THURSDAY, AUGUST 27, 1914.

THE NEWER EDUCATION.

(1) *Dr. Montessori's Own Handbook.* By Dr. M. Montessori. Pp. viii + 136. (London: Heinemann, 1914.) Price 3*s.* 6*d.* net.

(2) *The Montessori Method and the American School.* By Prof. F. E. Ward. Pp. xvi + 243. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 5*s.* 6*d.* net.

(3) *A Path to Freedom in the School.* By N. MacMunn. Pp. 162. (London: G. Bell and Sons, 1914.) Price 2*s.* net.

(1) A BOOK by Dr. Montessori is an event in the educational world; it creates an interest beyond that due to its intrinsic merit. The "Handbook" is a distinct advance on the "Method" in that the descriptions of how to use the apparatus are now given in orderly sequence and in much more detail; that the name "directress" is now replaced by "teacher," and that, instead of the "passivity," which was quite overemphasised in the "Method," we read in the "Handbook" of what the teacher has to do as well as to refrain from doing; and the importance of *teaching* the right way to do actions is fully recognised. There is, too, less of that tendency to decry current knowledge and practice which has undoubtedly done much to hinder appreciation of her own valuable work.

Like the "Method," the "Handbook" is disappointing in that it says nothing of the difficulties the teacher meets when the children do not behave in the expected way, nor are the principles by which the teacher must be guided dealt with. The book is in truth a *Hand*book, with the limitations of the "Handbook" or "Manual," as contrasted with a *brain*-book intended for those who work by intelligent application of principles rather than by rules. The reader, too, should be cautious in accepting the few physiological or psychological statements it contains. For example, a sharp distinction is drawn between sensory and motor training, though each involves the other; again, the psychology of the first paragraph of p. 122 will not withstand examination. But to those who have already grasped the principles on which their teaching should be founded, the "Handbook" will be of very real assistance. It gives, as might be expected, the best account yet published of how to use the apparatus. Dr. Montessori's deep sympathy with the child, her patience with its halting efforts, are beautifully visible throughout its pages. Patience, indeed, is not the right word, since it may suggest controlled impatience, and of impatience there is no trace; no matter how disappointingly slow the child's progress may seem to be, one cannot imagine Dr. Montessori doing otherwise than watching nature's progress with expectant and deeply interested hopefulness.

(2) Prof. Ward's book is for the most part a laborious, detailed, uncritical *résumé* of Dr. Montessori's views as given in "The Montessori Method." There are so many summaries, arranged numerically, and under (*a*), (*b*), (*c*), and so on, that the work is not stimulating—it does for the reader what he should do for himself. The best chapters are those not so directly dealing with Montessori practice.

(3) Of books criticising the meagre results of our secondary education there have been many, but none comparable in interest and importance with that of Mr. McMunn. Lively and vigorous in its English, sometimes putting conclusions more strongly than sober critics, even friendly ones may approve, it is, above all, valuable for its constructive side, and is the outcome of definite and successful experience. Inspired by Dr. Montessori's work, he endeavoured to found his class-teaching of older students on the concept of freedom, and the method of "partnership" was the outcome.

Nothing in education is wholly new, except perhaps the relative importance attached to the different means employed. Thus, in university classes in mathematics the writer, following the Jesuits, has for years put those students who understand to explain to those who do not—a plan excellent for both. Mr. McMunn improves much on this: in teaching French he arranges that the boys teach *each other,* irrespective of supposed ability; something like it has been done in teaching history, where by the aid of a school library each, even the most backward, is enabled to bring a contribution to the lesson.

Mr. McMunn has so worked out and applied his ideas that mutual self-education by the boys is carried to a much greater extent than in any other school, so far as the writer knows, and with extraordinary success—new intellectual life and interest have been generated in the boys, *especially in those who before were deemed stupid or backward.* If other teachers can use the method as he has used it, and apply it to other subjects, secondary education will take an immense stride forward.

In regard to little children, from Dr. Montessori in Rome; in regard to schoolboys, from Mr.

McMunn at Stratford-on-Avon; in regard to criminal or semi-criminal children of the streets, from Mr. Lane at the Little Commonwealth in Dorset, we learn of the wonders wrought by a wise respect for the individual personality of the pupil. Shall we learn the lesson they teach? Or shall we go on blindly in the ways of the past?

E. P. C.

THE "CONWAY" MANUAL.

The "Conway" Manual: being a complete Summary of all Problems in Navigation and Nautical Astronomy. By J. Morgan, T. P. Marchant, and A. L. Wood. Pp. 79. (London: J. D. Potter, 1914.) Price 5s.

THIS manual of navigation, as taught on board the *Conway*, gives the courses of instruction the cadets of that vessel go through to prepare them to qualify as navigators afloat.

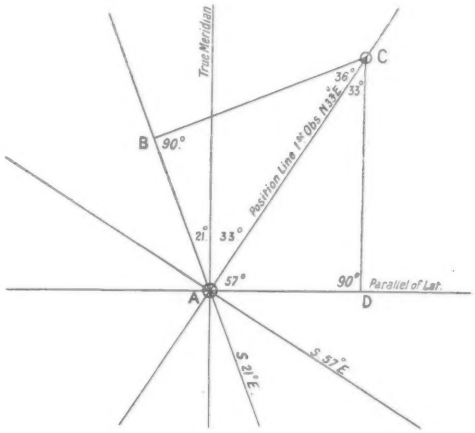
Quite properly the manual lays stress on the importance of all students being familiar with both plane and spherical trigonometry, as navigation is simply applied trigonometry, and entirely discards all rule of thumb methods, but in teaching the cadets the method appears to be to plunge at once into a statement of the formulas used—the sine formula, etc., without indicating what is meant by sines, cosines, tangents, etc. Surely in teaching beginners it is best to make plain what is meant by the expressions used.

In applying the formulas to practical navigation the manual adopts the method of zenith distances given by Marcq St. Hilaire about 1880, to the exclusion of all other methods. Now the method of position lines has been in use for nearly a century. When first started, the line of position was obtained by finding the longitude from the observation of the sun worked out with two latitudes some miles apart; the resulting longitudes gave a line on which the observer must be situated. When it became of importance to ascertain the compass errors, at the time of observation, the system of working with two latitudes was abandoned in favour of calculating the true bearings of the heavenly object, together with the longitude; as the observer must be on a line of position at right angles to the bearings of the heavenly object observed. If two heavenly objects were observed, in convenient positions with respect to each other, it is evident that the observer must be where those lines intersect, but even with one object only, by knowing the true zenith and polar distances, and the approximate co-latitude, the line of position on which the observer is situated can be placed on the chart at once, and frequently by steering along that line an accurate landfall be made. In this problem the only doubtful point is the co-latitude. By Marcq St. Hilaire's method an approximate hour angle is assumed, as well as an approximate co-latitude, and the true polar distance, to calculate an approximate zenith distance and true bearing, and the difference between the true zenith distance, as observed, and the approximate zenith distance, as calculated, plotted along the line of bearing of the heavenly object, and the lines of position parallel to each other plotted.

Lines of position are fully explained in Riddle's "Navigation," eighth edition, published in 1864, and can be obtained by the Marcq St. Hilaire method as well as by Sumners, or by calculating the longitude and azimuth of the heavenly body observed. When the sun is the heavenly object observed the zenith distance plan has the disadvantage of not giving the longitude and line of position. Witn two stars at or near right angles to each other this does not apply, but even then the method of calculating the longitude and line of bearing appears quite as advantageous as the zenith distance method. But what appears to be omitted from the "Conway Manual" in the practical work is all instruction relative to Dr. Ivory's method of double altitudes or to lunar distances, though in the case of the sun's double altitude given at page 74 the ship's position can be calculated at once by Dr. Ivory's method as expanded in Riddle's "Navigation," without trouble and without any plotting and position lines. Also, in the example of star double altitude at page 76, although the rate of the chronometer for a period of eighty-five days has to be applied to obtain the Greenwich mean time, nowhere is the student warned that in such a lapse of time the chronometer may, and probably would, have altered its rate, and that the most convenient way of ascertaining this in a ship at sea is by lunar observations.

It may perhaps be as well to point out also that in the problem on page 74, although the altitude at the first observation is corrected for the run of the ship, the latitude it is worked with is the approximate latitude of the ship at the first observation for both sets of the sun's altitude, at 11 a.m. as well as at 9 a.m. It will be found that if the hour angle and sun's bearing be obtained from the observations at 9 a.m., and the run of the ship be applied to that hour angle, as well as the elapsed time, a more correct hour angle will be obtained for the 11 a.m. observation, and the correct position got, as in the annexed diagram; where if A be the position of the ship at the

time of the second observation, as obtained by applying the run from the first observation, then AC will be the position line by the first observation, AB the line of bearing of the sun at the second observation, and the distance from A to B the difference of 36 miles, the difference of the zenith distance as calculated, using the corrected



latitude and hour angle, and, as observed, then BC will be the line of position at the second observation cutting the first position line at C. Drop a perpendicular CD on to the parallel of latitude, and the distance CD, and departure AD, are easily obtained by the traverse tables without any need of drawing the diagram to scale.

THE FOSSIL INVERTEBRATES.

Text-book of Palaeontology. Edited by Prof. C. R. Eastman. Adapted from the German of Prof. Karl A. von Zittel. Second Edition, revised and enlarged. Volume I. Pp. xi+839. (London: Macmillan and Co., Ltd., 1913.) Price 25*s.* net.

THE appearance of a new edition of Zittel's "Palæontology" is always something of an event in the palæontological world, more so, perhaps, than the publication of many a weighty monograph. For this is a work which appeals not only to the student, but to each expert in his own specialty. Some years ago one could say, "there are many text-books, but only one Zittel"; but this is a tribute that can no longer be paid, since there are now two Zittels. One, the German edition, recently revised by Prof. Broili, but still evincing the cautious conservatism of the original distinguished author; the other, the American edition, retaining the preface and the illustrations of the "Grundzüge," but in almost all other respects a very different work. It is the first volume of the second edition of this latter that is now before us.

As in the previous edition, Prof. Eastman has managed to secure the cooperation of a number of well-known authorities, most of whose names (not always correctly given) appear in this connection for the first time. With the exception of Dr. W. T. Calman and Dr. A. Handlirsch, all are citizens of the United States, and have therefore not been afraid to introduce drastic alterations. In this respect, however, there is considerable difference of treatment. While, for instance, the classification and account of the foraminifera have been entirely re-modelled by Dr. Cushman, the sections on radiolaria and sponges are almost unaltered, the latter still retaining on p. 71 the misprint *Ventriculites* for *Verticillites*. Perhaps the editor was in this matter well advised, but Dr. Wayland Vaughan might have done more with the corals; he has made a few slight changes and introduced Duerden's views of the septal development in hexacoralla, but he does not, except by a literature reference, direct attention to the important studies that have lately been made on our Carboniferous corals, and the student who turns up here the much-debated Archæocyathus will be disappointed.

In the hands of Dr. Ruedemann the graptolites are safe; but we look for something more than safety, at the least for some evolutionary scheme that shall enable the student to carry the leading facts in his head, and in this case the scheme would probably have the additional merit of truth. How different is Prof. Schuchert's chapter on the brachiopoda (based on his previous valuable synopsis, but incorporating "the brilliant results of C. D. Walcott" and "the important work of S. S. Buckman")! Here is evolution with a vengeance: the Orthidæ are defined as "progressive, divergent, and terminal Orthacea, derived out of the Eoorthinæ, etc." True, the student will have to find out elsewhere than in this volume what is the precise meaning of these evolutionary terms; but the search will do him a world of good.

If only a page can be spared for fossil jellyfish, the doubtful forms should give place to those now well known, and the figure should be of a better specimen. Under "Vermes" some of Walcott's Cambrian genera are illustrated, and there is a fresh note on alleged worm-tracks, but we meet with no great change until we reach the echinoderms. In revising this phylum four experts lent their aid, and the fact that Dr. A. H. Clark was one explains the suggestion "that the echinoderms are derived from acraniate crustacean ancestors, through the cirripedia." After this it is

tame to find the classification of both cystoidea and blastoidea following that of Bather. For the crinoidea, however, Dr. Springer naturally takes, with some modification, the main divisions established by Wachsmuth and Springer. The post-palæozoic genera are separated as an order, articulata, which seems rather a backward step; but it is interesting to have them arranged according to the views of Dr. A. H. Clark, even though much space is given to purely recent forms. Dr. H. L. Clark, who revises the asterozoa, seems timorous by contrast. Dr. R. T. Jackson (whose help throughout the editor acknowledges) has fortunately been able to deal with the echinoidea on the lines of his recent great monograph; our only regret is that the name centrechinoida (*vice* diademoida) has thus entered on its text-book career.

In the bryozoa, and in mollusca other than ammonoidea, we detect no great change; that important order has been entrusted to Prof J. Perrin Smith, who strikes a happy mean between the phylogenists and the geologists. With such revisers as Drs. C. D. Walcott, J. M. Clarke, P. E. Raymond, A. Petrunkevitch, W. T. Calman, and A. Handlirsch, the chapter on the arthropoda proves sound and up-to-date. The editor must have felt very happy when he had seen its last page through the press, and could turn to compile the index of more than 5500 names. We offer our congratulations and thanks.

MATHEMATICAL TEXT-BOOKS.

(1) *Le Hasard.* By Prof. E. Borel. Pp. iv+312. (Paris: F. Alcan, 1914.) Price 3.50 francs.

(2) *Intermediate Mechanics for Indian Students.* By F. C. Turner and Prof. J. M. Bose. Pp. xii+332. (London: Longmans, Green and Co., 1914.) Price 4s. 6d.

(3) *A Junior Trigonometry.* By W. G. Borchardt and the Rev. A. D. Perrott. Pp. xv+220+xvii+xx. (London: G. Bell and Sons, Ltd., 1914.) Price 3*s.* 6*d.*

(4) *Mathematical Papers. For Admission into the Royal Military Academy and the Royal Military College. For the years* 1905–13. Edited by R. M. Milne. (London: Macmillan and Co., Ltd., 1914.) Price 6*s.*

(5) *Bell's Outdoor and Indoor Experimental Arithmetics.* By H. H. Goodacre, and E. F. Holmes, C. F. Noble, P. Steer. Teacher's Book. Pp. xii+377. (London: G. Bell and Sons, Ltd., 1914.) Price 3*s.* 6*d.* net.

(6) *The Theory of Proportion.* By Prof. M. J. M. Hill. Pp. xx+108. (London: Constable and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

(7) *Dynamics.* By Prof. H. Lamb. Pp. xi+344. (Cambridge: University Press, 1914.) Price 10*s.* 6*d.* net.

(8) *Lectures on the Icosahedron and the Solution of Equations of the Fifth Degree.* By Prof. F. Klein. Translated by Dr. G. G. Morrice. Second and revised edition. Pp. xvi+289. (London: Kegan Paul, Trench, Trubner and Co., Ltd., n.d.) Price 10*s.* 6*d.* net.

(9) *Tables for Facilitating the Use of Harmonic Analysis.* As arranged by Prof. H. H. Turner. Pp. 46. (London: Oxford University Press, 1913.) Price 1*s.* net.

(1) IT has been said that "Chance is the measure of our ignorance," and if by this it is meant that any event, the causes of which we do not understand, is to be ascribed to chance, then chance is indeed a powerful factor in life; and many of our actions and policies are determined by our estimate of it. The mathematical theory is, of course, beyond the powers of the ordinary reader; no one, for instance, who had not received a special mathematical training could make much of the excellent article on "Probability" in the "Encyclopædia Britannica." But there are general considerations and conclusions which lie apart from technical difficulties, and it is these that form the substance of this volume.

The book is divided into three parts. The first considers the meaning of probability with illustrations from the tossing of a coin, cases of limited and unlimited alternatives and inverse probability; examples are taken in which different methods appear to yield different solutions of the same problem, thus paving the way to an instructive discussion on possible elements of ambiguity in the data. The second part deals with the applications of the laws of chance to sociology, biology, physics, astronomy, and chemistry; and the third with their practical and philosophical bearing on human affairs. All these topics should appeal to the general reader.

(2) This text-book is compiled with special reference to the needs of Indian students, and includes all that is required by the syllabus of Calcutta University. There is nothing particularly original in the treatment; and although the importance of practical work is emphasised in the preface, yet in the text itself there is not as much as will be found in most recent English books. For examination purposes it will, however, be found distinctly useful, since the book-work is set out clearly and there are a good selection of illustrative examples, worked out in careful detail. There is an unfortunate mistake in the section on circular motion, where it is stated that this implies the action of some force

acting *outwards* along the normal. We are glad to see that statics and dynamics are taken together, instead of, as often happens, being made to form distinct parts of the course.

(3) Most of the subject-matter of this book is included in the "Numerical Trigonometry" by the same authors, already noticed in these columns. There are additional chapters on solid geometry, multiple angles, and identities.

(4) Following their usual custom, Macmillan and Co. publish in a single volume the collected mathematical papers for admission to Sandhurst and Woolwich for the years 1905–1913. All the diagrams are reprinted as set, and a complete list of answers is appended. The volumes of this series are invaluable for army class work.

(5) The authors of this practical text-book have interpreted in an admirable manner the suggestions made in the Board of Education's Circular, Number 807. The course is planned to cover five years, and deals with length, area, volume, weight, and time. In addition to setting out in detail the experiments to be made, there is a number of useful notes for the teacher, enumerating such points as are likely to require special attention, detailing the requisite apparatus, and suggesting methods for organising the work of the class. Complete lists are also given at the end of the equipment that is (1) necessary and (2) desirable, together with useful information as to cost. The book is undoubtedly the work of capable and enthusiastic teachers, and the variety of the exercises is evidence of the thought that has been expended in the selection of material.

(6) The purpose of this book is to provide an account of the theory of proportion, suitable for elementary teaching. The main part of it is founded on an annual course of lectures given by the author in the University of London; but the concluding chapters are intended only for teachers or honour-students.

One of the chief points of difference between the theoretical development adopted by Prof. Hill and that of Euclid is the establishing of properties of equalities of ratios by the use of Def. 5, Bk. v., instead of introducing Def. 7, Bk. v., which gives the test for distinguishing between unequal ratios. The author is of opinion that this greatly simplifies the difficulties students meet with. For the first nine chapters, which form the elementary course, little mathematical ability is required; and a clear idea should be obtained of the meaning and nature of irrationals. Part II. deals with geometrical applications of Stolz's theorem on the test for equal ratios and further consideration of irrationals; and Part III. is historical, being a commentary on Euclid's work.

(7) This is the second volume of a treatise on mechanics, the first part of which deals with statics and has already been noticed in these columns. Together they form an excellent course of reading for scholarship divisions in secondary schools. In style, this volume closely resembles the first; the bookwork is cast in an interesting and refreshing form; the able student will find much that is highly stimulating, and the boy of ordinary capacity will appreciate the concentration on the fundamental processes required for the systematic solution of problems. Many boys are so easily bewildered by detail, that it is highly important to make them realise at the earliest moment how few and simple are the general principles of mechanics; and for this reason it is desirable to provide them with examples which require small analytical skill. In this respect, as in his volume on statics, Prof. Lamb has provided exactly what is most needed. A certain number of the traditional problems are naturally included, but the main body have been selected to illustrate principles and clarify ideas. There is an interesting appendix on the relation of abstract dynamical principles to human experience.

(8) More than twenty-five years have passed since Prof. Klein's classic treatise was first translated into English, and the nature of its contents and the line of argument are so well known as to render any account at the present time superfluous. In preparing this revised edition, Dr. Morrice has been fortunate in securing the assistance of Prof. Burnside.

(9) If a set of n values of a slightly varying quantity are taken, the expression representing them most closely is obtained from a Fourier series. To assist numerical computation, these tables, arranged by Prof. Turner, give the values of terms of the type $a_{r+1} \sin r\theta$, $a_{r+1} \cos r\theta$ to two significant figures, for values of n between 8 and 22, where $\theta = 2\pi/n$.

OUR BOOKSHELF.

India-rubber Laboratory Practice. By Dr. W. A. Caspari. Pp. viii + 196. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

It must be a great temptation to any chemist who writes about rubber at the present time to devote a considerable amount of attention to the views that are in the air on the constitution of this interesting substance, or substances, and to the bearing of recent developments in colloidal chemistry on the problems presented by the preparation and properties of rubber. Dr. Caspari has expressly omitted all reference to these subjects, and has limited himself entirely to the analytical problems which arise in the ordinary routine prac-

tice of an industrial rubber laboratory, viz., the sampling and analysis of raw rubbers, the nature and properties of the various substances—rubber substitutes, fillers, pigments, etc.—used in preparing manufactured rubber, and finally the analysis of manufactured rubbers.

The methods described and recommended are well chosen, and, indeed, are those which the author has found satisfactory in actual practice. The book is, in fact, so good that one regrets the decision not to include any account of the mechanical testing of manufactured rubber. The reason given for this decision is that this method of examination is as yet merely beginning to give rise to systematic laboratory practice. Both manufacturers and planters are now, however, taking up this subject seriously, and in view of this, a statement of the experience of so careful and conscientious an observer as Dr. Caspari would have been welcomed by all interested in this subject. It is to be hoped that when a new edition of this little book is called for, the author will still further increase its utility to the rubber chemist by adding a section on mechanical testing.

The book is very well produced and illustrated, and is remarkably free from misprints.

Ancient India, from the Earliest Times to the First Century A.D. By Prof. E. J. Rapson. Pp. viii + 199. (Cambridge University Press, 1914.) Price 3*s*. net.

It is not an easy task to write a popular introduction to the history of ancient India. A race, destitute of the historical sense, has left few records of early events save poems and dreary treatises on belief and ritual, coloured by religious antipathy and prejudices. The age of scientific excavation has scarcely begun, but even now the fresh material daily accumulating—epigraphical, numismatic, artistic—is so abundant and perplexing that the time for its scientific discussion has scarcely yet arrived. The ruling tendency of Indian history has always been centrifugal, and it is only at rare periods—those of Asoka and Harsha—that the story attains ephemeral unity, and, as a whole, it remains a record of the fortunes of petty States, without much material for a continuous sketch of social life or an account of the individual actors in the drama.

For those who desire an elaborate account of the facts, Mr. V. A. Smith's "Early History," now in its third edition, is available. Prof. Rapson is a master of the subject, and he has relieved the tedium of the narrative by some interesting disquisitions, such as a discussion of the rise of the study of Sanskrit, and of the processes by which some attempt at a chronology has been reached. The engravings of coins, architecture, and inscriptions are much to the purpose. He might have done more to illustrate the social side of the history, but so far as it goes the book forms an admirable introduction to work a knowledge of which has too long been confined to the specialist.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The First Description of a Kangaroo.

On reading Dr. Estreicher's letter under this heading in NATURE of March 19 (p. 60) I wrote to Mr. Petherick, who was kind enough to send me one of his articles on the subject reprinted from the *British Australasian* for May 6, 1897. This article gives the complete passage from Peter Martyr, part of which Dr. Estreicher quoted, evidently from memory.

The passage is as follows:—"Among these trees is found that monstrous beast with a snout like a fox, a tail like a marmoset, ears like a bat, hands like a man, and feet like an ape, bearing her whelps about with her in an outward belly, much like unto a great bag or purse. The dead carcase of this beast you saw with me, and turned it over and over with your own hands, marvelling at that new belly and wonderful provision of nature. They say it is known by experience that she never letteth her whelps go out of that purse except it be either to play or suck until such time that they be able to get their living by themselves."

There can be no doubt that this is the description of a marsupial, and to me it seems very clear that it refers to an opossum. "Hands like a man and feet like an ape" implies that all four feet were used for grasping, and I cannot understand how anyone could think such a description applicable to a kangaroo, especially when we are told that the creature had a "tail like a marmoset."

The following points in the description seem to me to point to the true American opossum rather than the Australian phalanger. "Bearing her whelps about with her" implies that the animal had a litter of young. The phalangers (and kangaroos) only give birth to a single young one at a time, though sometimes a second is born before the first leaves the pouch. "They say it is known by experience" implies that the animal lived in a country either inhabited by white men or in which white men had intercourse with the natives. Neither of these conditions can have applied to Australia in the fifteenth century.

W. B. ALEXANDER.

Western Australian Museum, Perth, W.A., July 11.

The "Green Ray" at Sunset.

Yesterday, Sunday, August 16, I was watching the sunset over the sea. I was using binoculars, and remarked that I had never seen the horizon so sharp. The waves could be seen on the edge of the sky.

I was watching with interest the rapid disappearance of the upper rim of the sun when quite unexpectedly the golden edge turned apple-green and seemed to lag for a second or two and then vanished.

The green line seemed to be broken into three, possibly by waves acting in the same way as a small irregularity on one edge of a spectroscopic slit acts on a spectrum. The waves were not big enough to be simple obstructions. R. C. T. EVANS.

Sandringham House, Marina Crescent,
Herne Bay, August 17.

[It is a pity that this well-known phenomenon due to atmospheric dispersion is not more frequently looked for.—Ed. NATURE.]

TREATMENT OF THE WOUNDED.

AT the meeting of the Academy of Sciences, held in Paris on Monday, August 10, a paper, of particular interest at the present time, was read by Inspector-General Edmond Delorme dealing with the treatment of the wounded in modern warfare.[1] General Delorme became a surgeon in the French Army during the last Franco-Prussian War, and has devoted his life to the advancement of military surgery, his text-book on that subject being recognised everywhere as a standard work. His opinion of the wounds inflicted by modern weapons is by no means pessimistic:—

"The military surgeons, at the present time," he writes, "must adopt the most conservative methods of treatment in the great majority of military wounds; indeed, such methods must be applied in practically every case of bullet wound. The opening of a modern bullet wound is so small that if the surgeon adopts strict antiseptic or aseptic dressings and refrains from probing the wound or making a systematic search for foreign bodies arrested in its track, it is possible to give the most favourable prognosis for wounds of this class. Thanks to aseptic and antiseptic methods of treatment, the wounded run less risk than in former times."

The pointed bullet, employed by the German Army, leaves very narrow wounds of entrance and exit when it penetrates the more fleshy parts of the body, but its track in the tissues themselves is marked by a considerable degree of destruction. Still, such cases, in General Delorme's opinion, should recover in the course of several days or perhaps weeks. On the other hand, wounds from shrapnel, or from deformed bullets, are often extensive, open, and complicated by the intrusion of clothing or other foreign bodies. Such wounds are not necessarily dangerous, but they frequently suppurate and require close attention when the wounded are being transported to the hospital at the base.

One naturally pays the closest attention to what General Delorme has to say regarding wounds of the abdomen—so fatal in former wars. During the last twenty years surgeons have so improved their technique that they now perform abdominal operations as safely as those on the limbs.

"The treatment of wounds of the abdomen," writes General Delorme, "deserves the closest attention of surgeons, particularly of those working at the front. We have new methods at our disposal which may ameliorate the results of a class of cases always regarded as of grave import. The advisability of operating on such cases in civil practice is open to discussion, but the case in war is quite different. In war the surgeons must lay aside any idea of opening the abdomen. The experience of all recent wars is against such means—experience in the Transvaal, Manchuria, the Balkans. In the Transvaal, even when abdominal operations were carried out by the most eminent surgeons, under the best conditions, it was found that those who were operated on yielded a smaller percentage of recoveries than the cases which were not subjected to operation."

[1] "Blessures de Guerre, Conseils aux Chirurgiens." Par M. Edmond Delorme. *Comptes rendus*, August 10, p. 394.

The modern German bullet, in full flight, leaves a very small wound on the wall of the abdomen, and seldom infects the wound by carrying clothing in front of it. The perforations produced by such bullets in the loops of intestine are minute and tend to close spontaneously. In some cases the bullet may pass between loops, leaving the intestinal wall intact.

The natural and salutary inclination on the part of the wounded to relieve both bladder and bowels, allowing the patient rest for some time, instead of hurrying him to the transport, allows a natural exudate to form round the wounded parts and favours the process of healing. For wounds of this kind the ancient methods of treatment seem best: absolute repose, refraining from prolonged transport, total abstinence from food and drink for several days, rinsing of the mouth, hypodermic injections of artificial serum, the administration of opium, and placing the patient in a half-sitting (Fowler's) posture.

It will be thus seen that the leading military surgeon of France advises conservative methods of treatment. We do not doubt that he is right. During an extensive action the surgeons at the front are suddenly overwhelmed by thousands of patients. It would be impossible to undertake, even were it advisable, prolonged and tedious operations—to give attention to one case and neglect the remaining ninety-nine. Fortunately, at least in General Delorme's opinion, such operations at the front are unnecessary; the surgeon's business is simply to see that the wounded are placed in the best circumstances to allow their natural recuperative powers to have the best chance of exerting themselves.

Much of the paper to which we have directed attention is of a purely technical nature and directly concerns only surgeons of the navy and army. But much of it concerns us all, and we are glad to think that as our arms of precision have improved our methods of treating the injuries produced by such improvements have not lagged behind.

NATURAL HISTORY, INFORMAL AND FORMAL.[1]

(1) THE first of the books before us aims rather at being a work of art than of natural history. It tells, with many a winding bout of linked fancy, of the yearnings of a boy and of a somewhat introspective stag. Never since the days of melancholy Jacques was such outpour of sentiment upon a stricken deer. To those who like this mood the book may be recommended, for it is curiously wrought and daintily embellished.

(2) The second book on the list strikes quite another strain: its author has certainly succeeded in his object, which is to introduce those of his fellow-creatures who love to live under the green-

[1] (1) "The Trail of the Sandhill Stag." By E. T. Seton. Pp. 93+plates. (London: Hodder and Stoughton, 1914.) Price 3s. 6d. net.
(2) "Wild Game in Zambezia." By R. C. F. Maugham. Pp. xii+376+plates. (London: John Murray, 1914.) Price 12s. net.
(3) "Animal Communities in Temperate America as Illustrated in the Chicago Region." A Study in Animal Ecology. By Dr. V. E. Shelford. Pp. xiii+362. (Chicago: University of Chicago Press; London: Cambridge University Press, n.d.) Price 12s. net.

wood tree to one of the few remaining regions of the earth where noble scenery is still unvulgarised and good shikar still unspoiled.

As a geographical expression, Zambezia is a little vague, but it appears from the companion map to include the Zambezi delta and the entire basin of the Zambezi system in the last five hundred miles of that great river's course. This country is said to contain every variety of climate and every beauty of African landscape. With the touch of a magician the author reveals tropical lowlands where vast seas of prairie, studded with islands of jungle, end in oceans of swamp and billowy sedge, the citadel of the water-birds—a very Nephelococcygia. Then up country he shows us the blue Zambezi, with many a feathery islet on her broad bosom, flowing through grassy plains and tranquil park-like expanses that lead into the forest primeval—gloomy shades made almost impenetrable by tangled creeper and thorny undergrowth, but breaking here and there into green pastures where the spongy soil is thickly printed with heart-thrilling spoor. Beyond the tropical jungle we pass to more temperately verdant hills, where cedar and bracken and the music of the waters call to mind the pine-woods of Scotland; and thence to rugged heights and clattered slopes and stark granite peaks that almost rival the Alps in grandeur and inspiration.

Of the fauna of this delightful land the author writes with discernment tempered with humour. He considers each species separately, in all its ways and bearings, from behemoth in the covert of the reed and fen to the coney that dwells among the rocks; if it be game, he has plenty of good stories to tell, in time and season, of its pursuit; and if it be an animal that can be made a pet of he can impart amusing information as to its manners and behaviour, good and bad. He also writes sensibly about game-reserves, tolerantly about the camera-sportsman, and with becoming scorn about the biltong-butcher. He has something to say about the tsetse-fly problem, and regards with unmeasured disapproval the barbarous proposals of those who think to settle it offhand by wholesale slaughter of game. It is to be wished that he could tell us something of the fly itself—whether we are, or are not, justified in assuming that an insect that produces a limited number of young, and nourishes them in her womb, must always carefully deposit them in some chosen habitat at that most critical period in their post-embryonic development when they become independent of her.

[Crocodile. From "Wild Game in Zambezia."]

Since he writes so methodically and scientifically of what he really knows, it is a pity that he sometimes wanders into the misty regions of pseudo-science, as when he discourses about the ancestry of the elephant, or gravely explains that since the horn of the rhinoceros consists of agglutinated hairs it has nothing in common with other horn.

The chapter on rifles and ammunition, tents, and all manner of equipment, camp regulations, etc., is full of most useful detail. But the list of stores required by two persons for a trip of two months

is startling. It almost shakes one's confidence in the author to learn that he cannot go into camp with a friend for two months without a dozen tins each of lobster and salmon, two dozen tins of sausages, and three dozen tins of fruits in syrup.

The book is well printed and beautifully illustrated.

(3) The third book on the list reveals Science in her severest mood. The aim of this conscientious piece of work is to elevate the outdoor pursuit of natural history into a serious academic study embracing each and every species of animal in relation to its environment, particularly to its organic environment, and still more particularly in its relations of interdependence with other species of animals. It may almost be regarded as embodying a formulary or ritual of the precepts and principles shown forth in the third chapter of that immortal book, "The Origin of Species."

The author adheres firmly and steadily to the great truth that all the animals of a given habitat form a definite interdependent association; but his application of the term "community" to an assemblage bound by ties so non-moral implies a cynical view of the ethics of communal life in this twentieth century. He sets out to determine by a prolonged and detailed study of a given territory —its streams, ponds, lakes, swamps, prairie, thickets, forests, etc.—the salient impressive features of its different kinds of habitat, and the character and exact specific composition of the animal-associations appertaining to each. An incidental end is to teach the sentimental person "sanity towards nature," and to show the practical man that he himself has much to find out before he can learn any animal to be a toad. So far so good; but the esoteric terminology of it all is wondrous pitiful, and there is much dressing up of old plain truths in confusing folds of majestic language—such as the following:— "The breeding instincts are the centre about which all other activities of the organism rotate, and the breeding-place is the axis of the environmental relations of the organism."

THE TOTAL SOLAR ECLIPSE OF AUGUST 21.

WHILE a number of expeditions were organised, and some were dispatched, to observe the total solar eclipse on Friday last, August 21, many were unable to take up their stations owing to the upheaval now taking place in Europe. It is, therefore, with the greatest satisfaction that we learn of at least two expeditions which successfully reached their destinations and observed the eclipse under most favourable weather conditions. The two parties were the observers from the Royal Observatory, Greenwich, consisting of Messrs. Jones and Davidson, and the expedition sent out by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies, composed of Fathers Cortie and O'Connor and Messrs. Atkinson and Gibbs.

According to a telegram to the *Daily Mail* of August 24, the Greenwich party, stationed at Minsk (Russia), observed the eclipse under good conditions in a clear sky, and photographs of both the corona and chromosphere were secured. It is stated that the form of the corona was of the intermediate type, *i.e.* of the square type, there being no large equatorial streamers or streamers in the regions of the solar poles. The corona is also stated to have been very bright. The party under Father Cortie, S.J., took up their position at Hernoesand in Sweden, and his telegram to the Royal Astronomical Society says, "Weather perfect. All operations successful. Intermediate corona."

It is interesting to mention that the Greenwich party was specially equipped for recording the ultra-violet spectrum of the chromosphere, while Father Cortie's instruments were more restricted to the yellow and red regions of the spectrum. Should the photographs turn out successful after development a wide range of the chromospheric spectrum will have been secured.

It is a great pity that Prof. Fowler was prevented from making any observations, for the interesting method of photographing the spectrum of the chromosphere for a long interval of time both before and after the total phase had every chance of being successfully tried.

ALFRED JOHN JUKES-BROWNE, F.R.S.

SELDOM has the triumph of force of will over the most serious disabilities been more strikingly illustrated than in the case of the subject of this notice. To most geologists engaged in field-work the loss of the full use of the limbs would seem to be fatal, but Jukes-Browne, in spite of all difficulties, continued his work as a geological surveyor for twenty years after the almost complete loss of his powers of locomotion.

Alfred John Browne was born near Wolverhampton in 1851; his mother was a sister of the distinguished geologist, J. Beete Jukes, whose work on the English and Irish geological surveys, and whose fame as a teacher in Dublin, are so well known; and young Browne, probably fired by his uncle's example, added the name of Jukes to his own as soon as he came of age.

After receiving his early education at Highgate, Jukes-Browne entered St. John's College, Cambridge, and, under the inspiring teaching and influence of Prof. T. G. Bonney, was able to add his name to the group of distinguished geologists who made that college famous during the last half of the nineteenth century. After a successful university career, Jukes-Browne joined the geological survey in 1874, and during the next nine years did good work in parts of East Anglia and Lincolnshire. But never, probably, a very strong man, the strenuous labours of a geological surveyor began to tell upon his health, enforcing retirement for a time.

Just at this period, however, a new and promising field of work opened out for the young geologist. The famous French palæontologist Hébert

had shown, by the study of the fossils of the enormous deposits of chalk in his own country, that not only must the deposition of this thick formation have occupied vast periods of time, but that the changes taking place in the fauna during those periods furnish us with evidence by means of which the almost homogeneous mass of strata could be divided into a number of clearly recognisable "palæontological zones." Hébert's distinguished pupil, Prof. Charles Barrois, of Lille, by a general *reconnaissance* over the chalk areas in the British Isles, proved that these zones could be traced through the length and breadth of our land. Jukes-Browne took up the task of working out the details of this classification of the English chalk strata, and after traversing during nine years the Cretaceous areas of the south and west of England published his results in three volumes of the Survey Memoirs.

In the winter of 1888–9 the state of his health caused Jukes-Browne to go to Barbadoes; there he worked at his favourite studies with such good purpose as to be able to publish, in conjunction with Prof. J. B. Harrison, a most valuable description of the upraised oceanic deposits in that island.

Besides his survey memoirs, and many papers in scientific journals, Jukes-Browne wrote three geological text-books and a work of more general and speculative character, "The Building of the British Isles," and some of his books have passed through several editions. The value of his scientific labours was recognised by the award of the Murchison medal by the Geological Society and by his election to the Royal Society. In 1902 the state of his health compelled his retirement from the Geological Survey, and the last twelve years of his life were passed at Torquay, where he died on August 14. J. W. J.

NOTES.

A CENTRAL NEWS message from Melbourne on Tuesday, August 25, states that a number of members of the British Association attending the Australian meeting are curtailing their proposed tour and preparing for a speedy departure for England. Exactly what this message signifies is, however, not quite clear. The Sydney session did not begin until August 20, and the intention was to proceed to Brisbane afterwards, but the whole meeting was not to last more than about three weeks from August 8.

IT is reported in the *Times* that an oil well has been discovered at Muir of Ord, about ten miles' distance from Inverness, and that tests are being applied to discover the nature of the oil and its commercial value, if any.

THE outbreak of war has, of course, made it impossible for drugs to be obtained from Germany as has hitherto been the case. In this connection the Government has appointed a committee to consider questions in relation to the supply of drugs in the United Kingdom. The members of the committee are: Dr. J. Smith Whitaker, Sir Thomas Barlow, Sir Lauder Brunton, Dr. A. Cox, Prof. A. R. Cushny, Dr. E. Rowland Fothergill, Dr. B. A. Richmond, Dr. F. J. Smith, Dr. W. Hale White, with Dr. E. W. Adams as secretary.

THE Government of Madras recently undertook an investigation into the causation, prevention, and possible cure of diabetes, and secured the services of Dr. S. W. Patterson as investigator. We learn from the Allahabad *Pioneer Mail* that the sum of 50,000 rupees has been given by the Raja of Pithapuram for the purpose of carrying out the project, and that the Surgeon-General with the Government of Madras has been requested to submit to the Government by an early date proposals for providing Dr. Patterson with the necessary staff and laboratory accommodation.

THE twenty-fifth annual general meeting of the Institution of Mining Engineers will be held at Stoke-on-Trent on September 9, under the presidency of Sir W. E. Garforth, when the following papers will be read, or taken as read:—The absorption of oxygen by coal: part ii., the quantity of oxygen absorbed; part iii., the thermal value of the absorption; part iv., the influence of temperature; part vi., the ratio of spontaneous heating of coal, T. F. Winmill; the absorption of oxygen by coal, part v., the influence of temperature on the rates of absorption of different parts of the Barnsley Bed, J. I. Graham; self-contained rescue-apparatus and smoke-helmets for use in irrespirable atmospheres, Dr. J. S. Haldane; the unknown clays in coal-mines, Dr. J. W. Mellor.

IN the June number of *Folk-lore* Mr. J. H. Powell discusses the rite of hook-swinging in India. He describes, with numerous good photographs, the ceremony which he witnessed in the Manbhum district of Chota Nagpur in 1912; and he has collected accounts of the rite from that of Duarte Barbosa in Malabar down to recent times. He compares it with the meriah sacrifice of the Khonds, which Sir J. Frazer explains to be a fertility rite, and he regards it as a survival of human sacrifice. The facts recorded in the article are useful, and the argument is ingenious; but the object of the ceremony still remains obscure. On the analogy of other swinging rites in other parts of the world, it may be suggested that the rotation of the victim is intended to disperse, as a fertility charm, the *mana* of the performer, who by submitting to the rite is believed to be sacrosanct.

THE Congress of Archæological Societies, in issuing its report for the past year, directs attention to the passing into law of the Ancient Monuments Consolidation and Amendment Bill, and suggests that societies affiliated to the union, if they have no special earthworks section, should appoint some competent member to watch over the earthworks in their district. It announces with pleasure that steps have been taken to place Worlebury Camp, Somerset, under the protection of the Act, and that steps have been taken to stop the damage that was being done to Bokerly Dyke and some ancient remains near Bristol. But much destruction, as at the Burh of Edward the Elder at Witham, and of Whitehawk Camp near Brighton, still continues, and it is pointed out that the absence of

power to compensate owners for loss incurred in the application of the Act is the weak point in the existing legislation on the subject.

MR. R. F. GILDER has issued a catalogue of the remains discovered in the course of a survey conducted by him of a series of prehistoric dwellings in Douglas and Sarpy Counties, Nebraska. There were believed to be depressions caused by bison wallowing in the mud, but are now proved to be of human origin. Along the Missouri river as far as the Platte some forty ruins have been explored, and the specimens collected are now deposited in the Omaha Public Library Museum. The collection consists of numerous articles made of bone and deer horn, pottery, prehistoric pipes, and various ornaments. The most remarkable object is a human head carved out of pink soapstone, which is believed by some competent archæologists to be unique among American collections.

WE have to acknowledge the receipt of a copy of the tenth part of Dr. Koningsberger's *Java*, the greater portion of which is devoted to the fauna of the coast region.

AN extraordinary destruction of gulls and other seabirds at Teesmouth, as the result of a thunderstorm accompanied by the fall of hail and lumps of clear ice, on July 2, is recorded in the August number of *British Birds*. The bodies of three hundred gulls were counted within a distance of three-quarters of a mile, exclusive of those by the side of the breakwater.

FROM the report for the year ending April 30, published in the July number of the *Victorian Naturalist*, we learn that the Victoria Field Naturalists' Club continues in a flourishing condition, although the attendance at the excursions has been diminished owing to the greater demands of military training. Special efforts were made in the matter of bird-protection and the prohibition of the feather-trade.

A SPECIAL double number (August and September) of the *Irish Naturalist* is devoted to an annotated list, by Mr. N. Colgan, of the opisthobranch molluscs to be found on the coast and adjacent shallow water of county Dublin. The Malahide River, or channel, by which the Malahide Creek is alternately filled and emptied, is a classic locality for these organisms, and was the source, in 1844, of specimens described by Alder and Hancock as new species.

Bird-lore for July and August contains a noteworthy letter from Mr. Abbott H. Thayer in regard to the alleged recent diminution in the numbers of the commoner birds in the United States. Impressed with the belief that the replies to question-lists issued to the general public are misleading, the author put himself in communication with Prof. H. Münsterberg, the Harvard psychologist, who unhesitatingly regards the answers as untrustworthy and the result of imagination.

THE Royal Zoological Society of New South Wales has started an illustrated journal of its own—the *Australian Zoologist*—of which the first number was published at Sydney in June. Among its contents is an article by the Rev. T. R. R. Stebbing on a third species of the exclusively Australian genus of caprelline marine crustaceans known as Paraproto. In a second Mr. A. R. McCulloch illustrates the remarkable sexual dimorphism of a pipe-fish, *Stigmatophora nigra*, and likewise describes, under the name of *Histiogamphelus briggsii*, a new generic and specific representative of the same group.

TO the series of greatly enlarged models in the Natural History Museum illustrating the structure of insects and other invertebrates harmful to man or domesticated animals have been added several of the bont-tick (*Amblyoma hebraeum*), of southern and central Africa, which transmits heart-water to sheep, goats, and sometimes cattle. With one exception the models are twenty times natural size, and show the male and female under normal conditions, the fully-gorged female (a truly disgusting object), and the larva, the last represented by two models, are multiplied by 20 and the other 120. This interesting exhibit is at present placed in the central hall.

ANOTHER special exhibition in the central hall of the museum includes two cases—originally arranged for the conversazione in connection with the congress of dental surgeons—illustrating some of the most remarkable types of vertebrate dentition, both recent and fossil. The coiled dental spiral of Helicoprion and the button-like teeth of Lepidotus are noticeable in the fish series, while reptiles are represented, among others, by Placodus and Hyperodapedon, and mammals by the marsupial Thylacoleo, Arsinoëtherium, Toxodon, the primitive cetacean Prozeuglodon, and—most interesting of all—the head of a fœtal rorqual from South Georgia with the row of temporary teeth on either side of the upper jaw. Other preparations show the rise and development of the plates of whalebone which eventually cover the entire palate in this and other whalebone-whales.

THE "Report on Scottish Ornithology in 1913, including Migration," by Evelyn V. Baxter and Leonora Jeffrey Rintoul (Oliver and Boyd, Edinburgh; 1*s.* 6*d.* net), is a welcome publication. It summarises in convenient form the ornithological happenings in Scotland during the past year. Following the introductory remarks comes a section on species and subspecies new to Scotland, which is of special interest. The dusky willow-warbler (*Phylloscopus fuscatus*), an Asiatic species not hitherto recorded in any part of Europe, was met with on Auskerry on October 1. New to Scotland during the year, although previously recorded in England, were the lesser grey shrike, the melodious warbler, the Indian stonechat, the gull-billed tern, and the Scandinavian subspecies of the lesser black-backed gull. Scarcely less interesting are many of the records in the longer section on birds new to faunal areas, and uncommon visitors. In the section on extension of breeding range, we note that in 1913 the gadwall, the pintail, and the great crested grebe were all recorded for the first time as breeding species in the faunal area of "Moray." Among the notes in the section "Summer and Nesting" we find

several relating to an unexplained scarcity of sea-fowl at various west coast breeding stations. There follow short sections on winter, ringing, plumage, and habits, etc., each of which contains a number of interesting records. A summary is then given of the course of migration during the year, a paragraph being devoted to each month. In the remaining two-thirds of this report of ninety-six pages we find a detailed list of the year's records arranged according to species. There is also an adequate index. The observers are to be congratulated on their effective report, the outstanding feature being the large number of uncommon visitors and the addition of no fewer than five new birds to the Scottish lists.

THE meteorological charts of the North Atlantic Ocean for August issued by the Meteorological Office and other institutions, show that ice conditions have considerably improved since the previous month. Bergs were only met with to any great extent north of 47° N.; the most westerly position in which field ice, with fragments of bergs embedded in it, was seen this year was 42° 18′ N., 62° 43′ W. The first issue (July 16) stated that mist and fog were prevalent at times, and extended up to the Arctic circle. During August, fog over the North Atlantic is in a transition stage; a remarkable feature is said to be its tendency to occur along the parallel of 20° N.

THE renewal of Antarctic exploration and research will bring into prominence the importance of the knowledge of ice conditions in the south polar regions. It is probably well known that the monthly meteorological charts of the Indian Ocean issued by the Meteorological Office usually contain particulars of icebergs of the southern hemisphere, with charts. The issue for September, *e.g.* gives tables of icebergs met with each month during the last twenty-nine years, and also between January and May of this year. The summaries published during past years show that the epochs of frequency are variable, and that bergs may be met anywhere poleward of the parallel of 30° S. Heights of from 800 to 1700 ft. are not uncommon, and in several instances the lengths have been estimated to extend to many miles. It is stated that, unfortunately, angular measurements are seldom recorded.

IN "La Forme de la Terre" (Paris: Hermann et Fils) Dr. Vérronet has written an extremely interesting note on the history of researches into the form of the earth's surface. Pythagoras, Eratosthenes, the forgotten Paris philosophers of the fourteenth century, and Fernel, all played a part in building up our present knowledge. But it is from the work of Cassini that modern geodesy may be said to date. The disagreement that he found between geodetic measures and the results of mathematical reasoning led the Paris Academy to send out an equatorial and a polar expedition to measure meridian arcs so as to settle whether the earth is an oblate or a prolate spheroid. The result then as afterwards more than once was to confirm the conclusions of the mathematicians. Lately a readjustment of geodetic measures has again been made, in terms of such hypotheses as isostasy, to bring the measured value of the earth's ellipticity into accord with the theoretical value deduced from the constant of precession. Despite the attempts at readjustment, Dr. Vérronet insists rightly that the ultimate decision must lie with the geodesist, as the value given by the constant of precession depends on the hypothesis that the internal constitution of the earth is essentially fluid. This would appear to be Dr. Vérronet's own view, and by the aid of it he indicates some interesting conclusions as to a belt of earthquake areas in the neighbourhood of latitude 35° (San Francisco, Lisbon, Sicily, Japan). The range of uncertainty is steadily diminishing, and the increased accuracy of the modern work is clearly indicated in the pamphlet. We note one small error—Huyford is spoken of as an English worker. The very brief criticism of Darwin's tidal friction as applied to cosmogony is not at all convincing, and should be either amplified or omitted in any subsequent edition.

A PAPER on the demagnetisation factors of cylindrical rods in high uniform fields, by the late Prof. B. O. Peirce, of Harvard, appears in the June number of the Proceedings of the American Academy. With the help of a large solenoid nearly two metres long, capable of producing a magnetic field of 2500 gauss at its centre, the magnetic flux for high fields through the various sections of rods of different lengths of the same material were measured. It was found that at fields of the order of 2500 gauss the rods need only have lengths about 25 or 30 diameters for the magnetic flux through the central section to be equal, to within a small faction of 1 per cent., to that which would be obtained with a rod of infinite length. If an accuracy of ½ per cent. only is required the rod need only be 15 diameters long. These conclusions have been verified on several specimens of soft iron and mild, tool, and magnet steel. For uniformity of field the magnetising coil should be about 25 of its own diameters longer than the test piece.

ONE of the most interesting cases of the presence of abnormal constituents in the urine occurs in *pentosuria*, when pentoses or five-carbon sugars are found in considerably quantity. Since the work of Neuberg in 1900, the pentose present in such cases has generally been regarded as *dl*-arabinose. Messrs. E. Zerner and R. Woltuch, in the *Sitzungsberichte* of the Vienna Academy of Sciences (vol. cxxii., p. 879), now bring forward good evidence to show that in two cases they have studied the sugar is *d*-xylose. In these cases the urine showed considerable reducing power, but no rotatory power. The osazone isolated had the same melting-point as ordinary *l*-xylosazone, but an opposite (positive) rotation; when the osazone was mixed with *l*-xylosazone the melting-point of the mixture rose 40°—a behaviour which is good evidence of its being *d*-xylosazone. The occurrence of *d*-xylose under such conditions is a striking example of abnormal metabolism, especially as the ordinary form of xylose which occurs in plant-materials is the lævo-form.

THE *Engineer* for August 7 contains an account of a fireless locomotive built by Messrs. Andrew Barclay,

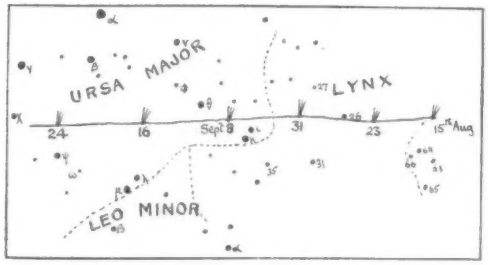
Sons and Co., Ltd., of Kilmarnock, and supplied to the Admiralty for service at one of the explosive depôts, where the question of absolute safety from fire is of the first importance. The locomotive has a reservoir partly filled with water, and is charged with high-pressure steam from a boiler placed outside the danger zone. It can work on one charge of the reservoir for several hours on continuous hauling, or for a much longer time on ordinary shunting work. It can stand for twelve hours in ordinary open-air temperature with small loss of steam, and can run back to the charging station under the very low pressure of 15 lb. per square inch. All the test conditions were more than fulfilled at the trials. The engine is not only fireless, but the rubbing surfaces, such as the brake blocks, and the impact points, such as the buffers, have been rendered sparkless by the use of special facings.

THE lack of supplies of glass and porcelain from Germany and Austria, on account of the war, has affected various businesses depending upon them. We are informed, however, by the Thermal Syndicate, Ltd., manufacturers of pure fused silica, that it is still in a position to supply its "Vitreosil" ware promptly, as this substitute for porcelain and glass is made entirely in the works of the syndicate at Wallsend-on-Tyne.

"THE Report of the Fourteenth Meeting of the Australasian Association for the Advancement of Science" has been recently issued by the Association from its permanent office in Sydney. It is edited by Dr. T. S. Hall, and contains a full account of the proceedings of the meeting held at Melbourne in 1913.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—Little news is at hand concerning observations of Delavan's comet. During the present week the object will be situated in the constellation of the Lynx pursuing a course nearly midway between the stars 27 and 31 in that constellation, and at right angles to a line joining these two stars. The small chart below, given previously in this column on August 13, is reproduced here again for reference:—



Mr. W. B. Tripp, writing from Isleworth on August 22, says that he observed the comet on the night of August 21 with a binocular field-glass. He describes it as of "substantial proportions promising to be a fine object later."

THE LARGE CANADIAN REFLECTOR.—The Journal of the Royal Astronomical Society of Canada for May–June (vol. viii., No. 3) contains two illustrated articles dealing with the proposed site and the observing conditions for the large 72-in. reflector; these are contributed by Messrs. W. E. Harper and J. S. Plaskett. An examination of the seeing conditions of many scattered regions has resulted in the choice of a hill, Little Saanich, 732 ft. high, situated seven and a half miles from Victoria. While Mr. Harper admits that the transparency of the air at the Lick Observatory is superior to any place examined by him in Canada, he holds the opinion that in the matter of low temperature range and the character of the seeing itself conditions may be looked for to equal those upon Mount Hamilton. The Government of British Columbia has considered the whole project in a broad-minded way and agreed to provide 10,000 dollars for the purchase of the land and to build a road to the summit of the hill. Fifty acres of land have been secured. As regards the instrument itself, the disc for the mirror is ready for shipment, and it is stated that there is every prospect of the telescope being ready for erection next year. Messrs. Warner and Swasey are the constructors, and Mr. Plaskett says that he is in the highest degree delighted with their work, and firmly convinced that "this telescope in rigidity, suitability, and convenience will be away ahead of any hitherto built."

RAPID CONVECTION IN STELLAR ATMOSPHERES.—In this column for April 30 of this year (vol. xciii., p. 224) reference was made to the new interpretation to the observed displacements of the solar lines suggested by Mr. Evershed. The observations were explained by a very rapid descent of the cooler gases and vapours upon the body of the sun, most rapid in the higher levels, and less rapid as the successively lower levels were reached, combined with small effects due to pressures less than one atmosphere. Prof. W. W. Campbell points out (Lick Observatory Bulletin, No. 257) that these observations give us apparently a measure of the general convectional circulation in the sun's atmosphere, which, if confirmed, "must be considered as of very great importance." These considerations lead him to inquire into what may be occurring in the atmosphere of other suns. Assuming that surface temperatures of stars must be largely a function of their convection-activity, a sluggish star, *i.e.* one with little convection, should have a relatively cool surface, while a massive star, approximating to a perfect gas, should have a large convection and have relatively a hot surface. Having found that the radial velocities of Class B stars are observed about 4·5 km. a second too great (then attributed to pressure in the absorbing layers), Prof. Campbell, in the light of Evershed's results as regards the solar atmosphere, puts forward the view that this excess is probably due to the existence of relatively unobstructed radial circulation. This circulation would bring the internal heat to the surface, with little loss of time, to replenish loss by radiations to surrounding space. If the sun's atmosphere, which is sluggish, can account for a speed of 1 km. a second, a relatively hot star like those of Class B might rationally have a velocity of 4·5 km. a second.

A NOVEL COMBINATION OF INSTRUMENTS.—Dr. Frank Schlesinger in the Publications of the Allegheny Observatory (vol. iii., No. 13), gives an account of the solar spectrograph of that observatory and the vertical telescope with which it is used. These instruments are the gift of the Hon. H. Kirke Porter, and they form part of the Keeler memorial telescope. The Keeler memorial telescope is a 30-in. reflector, and its mounting is used not only as a polar heliostat carrying an 18-in. mirror, but as a coelostat also with an 18-in. mirror. The telescope is mounted on a tall pillar circular at its upper end, and the dome is raised corre-

spondingly high. Round the upper portion of this pillar is a strong lattice work structure, capable of rotation round the pillar, and to this is fixed the vertical telescope with a second mirror and the objective at its upper end, the lower end carrying the large spectroscope, the collimator of which is vertical. For different declinations of the object under investigation the vertical telescope can be moved round in azimuth. In the communication in question Dr. Schlesinger describes all the chief portions of the instruments in detail, and numerous reproductions accompany the text. The latter part of the paper contains an investigation on the rotation of the sun by spectroscopic means made with the instrument described briefly above. Reference should be made to the paper itself for details, but the interesting table, showing the formulæ derived for the solar rotation by the spectroscopic method, may be here reproduced :—

	Formula	Equatorial Velocity km.
Duner	$14\cdot81-4\cdot2\sin^2\phi$ ...	2·09
Halm	$14\cdot53-2\cdot5$ ...	2·05
Adams	$14\cdot54-3\cdot5$ ...	2·05
Storey and Wilson ...	$14\cdot75-3\cdot2$ ...	2·08
Plaskett	$14\cdot37-4\cdot0$ ...	2·02
De Lury	$14\cdot04-4\cdot0$ ...	1·97
Hubrecht	$13\cdot23-3\cdot2$ ...	1·86
Evershed and Royds ...	13·77 ...	1·94
Schlesinger	$14\cdot17-3\cdot4$ ...	2·00

It should be stated that Duner's and Halm's observations were visual, and that Hubrecht found a difference of 0·8° between the coefficients of $\sin^2\phi$ for the two solar hemispheres and the value given above is the mean. Dr. Schlesinger is strongly of the opinion that the causes of the diversity of the results are due to systematic errors at the telescope and at the measuring machine.

FLUCTUATIONS IN THE YIELD OF SEA FISHERIES.[1]

THERE can be little doubt that this report by Dr. Hjort will mark an epoch in the history of scientific fishery investigations. If the arguments upon which its conclusions are based successfully withstand the test of criticism, there has been established a method of predicting the probable future course from year to year of some of our most important fisheries, which should be of the utmost value both to those engaged practically in the fishing industry and to those responsible for fishery administration.

The report is the result of many years of observation, and although the lines upon which the work has proceeded, and the character of the results which were expected, have been described by Dr. Hjort and his fellow-workers from time to time, this is the first report in which the whole matter has been brought forward in a comprehensive way, and the first time that all the data upon which the conclusions are based have been available. It is now possible to form a judgment as to the value of the work already done and as to the promise which it holds out of still more useful results in the future.

It is one of the most characteristic features of the great sea fisheries that they are subject to remarkable fluctuations from time to time. Sometimes these fluctuations are seasonal, sometimes annual, but more often, perhaps, we have a series of years of successful fishery, followed by another series of comparatively lean years. These fluctuations are especially noticeable in the case of the fisheries for the so-called pelagic fish, such as the herring, mackerel, pilchard, and anchovy, and, to a less-marked degree, in the case of the cod and haddock. Dr. Hjort's principal results refer to the herring, but a considerable amount of attention has also been given by him and his colleagues to the cod and haddock.

The case of the herring is the most conclusive. The main evidence has been obtained by the determination of the age of the fish from the markings on the scale. As in the case of many other fishes, there is little or no growth of the fish during the winter, and the difference in growth between winter and summer is clearly marked on the scale of the fish, the period of small winter growth being represented by a dark mark or ring. By counting the number of such rings the age of the fish can be determined, so that the year in which it was born becomes known. In a sample of the fish taken at any particular time it is therefore possible to determine in what proportions the different year classes are represented.

This method of age analysis has now been applied to Norwegian herring for a series of years with somewhat remarkable results. It has been found during the period 1907 to 1914 that fish of the year class 1904, that is to say, fish born in the year 1904, have occupied a very prominent position throughout, at first forming a large proportion of the shoals of smaller herring ("fat herring" as they are called in Norway, fish from 19–26 cm., still quite immature), and in later years being equally prominent amongst the larger fish ("large herring," fish from 27–32 cm., and "spring herring," the actually spawning fish). The following table shows the percentage of fish of the 1904 year class in the samples examined each year from 1907 to 1913 :—

Per cent. 1904 in	1907	1908	1909	1910	1911	1912	1913
Among fat herring ...	51·3	37·8	16·9	4·5	0	0	0
Among large herring	7·7	51·6	48·8	59·6	46·0	52·5	58·6
Among spring herring	1·5	34·8	43·7	77·3	70·0	64·3	64·7

The 1904 fish, therefore, formed more than 50 per cent. of the immature "fat herring" in 1907, and occurred amongst this class of fish in diminishing proportion until 1910. Amongst the "large herring," 51·6 per cent. were 1904-spawned fish already in 1908, and fish of the same year class occurred in large proportions each year until 1913, when there were still 58·6 per cent. Turning to the "spring herring"—the large spawning fish—the 1904 group was represented each year by a larger percentage, until in 1910 it constituted 77·3 per cent. of all the fish. Since that time the percentage has only slightly fallen off, being still 64·7 per cent. in 1913. In the last chapter of the report the figures for 1914 are given, the percentages of the different year groups amongst the spring fish being as follows (p. 219) :—

Spring Fish, 1914. *Total number of Herrings examined* 2205.

Age in Years... ...	4	5	6	7	8	9
Year of Birth	1910	1909	1908	1507	1906	1905
Percentage of fish in each age group ...	0·6	3·3	6·9	5·2	7·2	13·9
Age in Years... ...	10	11	12	13	14	15
Year of Birth ...	1904	1903	1902	1901	1900	1899
Percentage of fish in each age group ...	54·3	5·0	1·5	1·2	0·4	0·5

In the year 1914, therefore, we still have, in the samples examined, 54·3 per cent. of the fish derived from the spawning of the year 1904. It should be added that the 2,205 fish are the combined total of eight samples taken at different points on the Nor-

[1] Fluctuations in the great fisheries of Northern Europe viewed in the light of biological research. By Johan Hjort. Con. perm. internat. Explor. Mer. Rapp. et proc. verb. XX. Copenhagen, 1914.

wegian coast, and that each individual sample shows the same predominance of the 1904 class. It is also equally well shown in seven samples of "large herring" taken during the winter of 1913–14.

The next step in Dr. Hjort's argument is based on a study of the fishery statistics showing the fluctuations in the total yield of herrings of the different kinds. He is able to show that a marked increase of the yield occurred in those years in which the 1904 class became prominent.

The report then goes on to a study of the cod and haddock, and evidence is produced of a similar series of phenomena in the case of these fish. Again, the 1904 year class is predominant for a number of years, and its abundance gives rise to a successful fishery.

Summing up the whole matter, Dr. Hjort claims that the renewal of the stock of fish does not take place, as in any human population, by means of a more or less constant annual increment in the form of new individuals, but that, in the case of the species investigated, it is of a highly irregular character. "At certains intervals, year classes arise which far exceed the average in point of numbers, and during their lifetime, this numerical superiority affects the general character of the stock, both as regards quantity and quality, thus again exerting a decisive influence upon the yield of the fisheries in both respects." These rich year classes make their presence felt when they are still quite young, and their influence on the yield of the fisheries extends through a number of years. It should, therefore, in future, by means of properly organised investigations, be possible to ascertain beforehand the probable general course of the fisheries over a series of years. Such predictions will, of course, be liable to be upset by special circumstances, both of a general and of a local character. Nevertheless, there is now good reason to hope that indications of great practical value may be given, if the methods of investigation advocated by Dr. Hjort are continued upon an adequate scale. E. J. A.

STUDIES OF TROPICAL DISEASES.[1]

THIS report consists of the report of the committee (2 pp.) and six appendices, the first of which deals with anti-malarial measures in the Crown Colonies and protectorates, etc., the remainder with reports of the work done in various laboratories. To consider, first, Appendix I. The data in this appendix are mainly statistical. They seem to us to be deficient in two ways. (1) The figures are not scrupulously accurate, or at least differ from other official figures. (2) Information is lacking which seems to be essential to an appreciation of the meaning of the figures. Of want of accuracy, the following are examples. On p. 11 in the Mauritius report the number of deaths ascribed to fever (malaria *included*) is given as 4498, whereas in the annual report for Mauritius the deaths due to malaria *only* are given as 4619. Again, under the heading, "Government Hospitals," we find malarial fever: admissions 2321, deaths 30, whereas in the annual report for Mauritius we find 3063 cases of malaria, and 43 deaths. The discrepancy here may be due to the fact that in the latter case other than hospital cases are recorded, but if this is so, at any rate they find no place among the data in this report.

Again, comparing the figures given in this report and in the annual medical report for the Straits Settlements, we find the figures for malarial admissions to be 9172 and 9474 respectively, a difference of 302. In the corresponding reports for Nyasaland we find the population given as 1,000,659 and 1,001,895 respectively. In the Southern Nigerian report (p. 35) we find the following puzzling figures under malarial fever, viz.:—Admissions, 6; deaths, 10; admissions, 7; deaths, 5; admissions, 1; deaths, 10. And again, under "Government Hospitals," we find the admissions given as 9687, and two lines further down as 1365! Under "Blackwater Fever" four deaths are recorded, but no admissions are given, and it is only by referring to the annual medical report that we find that the number of cases in the colony was twenty-three. Not to pursue the subject further, we would only add that in our opinion the heading, "Deaths Ascribed to Fever," is ambiguous, as apparently some medical officers have found it to be, for some change the heading to "Malaria Fever," others say "malaria included," whereas others again subdivide it into malaria, typhoid, and non-specified fevers. We think this heading should be changed to "Diseases During the Year," and divided into various sub-headings, *e.g.* malarial fever, blackwater fever, etc., with the addition, if necessary, of unclassified fevers, and in each instance where possible cases as well as deaths recorded, as is done under heading 6 "Government Hospitals."

The second criticism we have to make is that information is lacking which is necessary to give the figures their full value. While dreading to suggest any addition to the really burdensome labours of those who have to compile these reports, yet we cannot help feeling that a mere record of population and malarial deaths tells us less than we ought to know. In our opinion, for these figures to be really of value we should know, besides the total population, that of each race and the deaths in each race. For instance, we are given, on p. 14, the European, Chinese, "other races," and Malay population of the Straits Settlements, but while we are told that the total births are more than 20,000, we are given no idea as to what races were responsible, and similarly we cannot tell among what populations the malarial deaths occurred. We have dwelt on these points because it seems to us that sooner or later the question of the compilation of the figures in reports of this kind and in the annual medical reports must be seriously considered. It is scarcely an exaggeration, we think, to say that at present no two annual medical reports are based on exactly the same plan, and we actually find that the official year is not identical in all. One point will not be disputed, viz., that absolute accuracy is necessary, and this is by no means an easy matter to attain, as everybody knows who has had to make up tables of figures. Whether these matters should not be in the hands of trained statistical officers, instead of being thrown on the shoulders of already overworked medical officers is a matter for consideration.

It is impossible to give shortly an adequate notice of the various researches recorded in appendices ii.–vi., as the subjects differ widely. It is evident that much valuable research is being done and interesting results got, but it occurs to us whether practical results—and we think we may assume that this is the main object of most of these researches—could not be got more quickly if the forces now scattered in various directions were to some extent concentrated on certain problems. For instance, we consider that each of the reports on the use of salvarsan in yaws (three in number) is more valuable than it would have been if it had stood alone. On ankylostomiasis we have only one report. It would be a gain to check the results recorded in it by experience elsewhere. So while not wishing to limit in any way a man's predilection, we think that coordination would be of advantage. The report is priced at 2*s.* 4*d.*, but we hope that every medical officer receives a copy gratis. J. W. W. S.

[1] Report of the Advisory Committee for the Tropical Diseases Research Fund for the Year 1913.

SOLIDIFICATION OF METALS.

THE first Report to the Beilby Prize Committee of the Institute of Metals on "The Solidification of Metals from the Liquid State," by Dr. C. H. Desch, is published in the current number of the Journal of the Institute. It consists of a very interesting and comprehensive review of the literature bearing on the subject, in conformity with the first part of the scheme of Dr. Beilby, which included both the preparation of a summary of the existing knowledge on the subject of the solidification of metals and an experimental investigation of certain parts of the subject. The report deals first with the cellular structure of metals, and it is shown that more than one apparently cellular structure may be detected in metals under suitable conditions. The crystallisation of metals is next approached, and the formation of crystallites or crystal skeletons. Attention is very rightly directed to the few opportunities which occur for the goniometrical and physical study of isolated crystals of metals. For there can be no doubt that much valuable information would be obtained from such an investigation, which would also be of particular value as throwing light on the phenomenon of hardness. In a solidifying metal crystallites start at numerous independent centres, and each grows as a crystal until interfered with by its neighbours, which interference gives rise to the so-called "allotriomorphic" formations of irregularly bounded crystals.

The foam-structure theory of Quincke is next dealt with, and shown to be carried much too far in its application to metals; for the theory affords no explanation of the absolutely firmly established geometrical properties of crystals. Cellular structures in cooling liquids are next described, and then comes a most interesting section on liquid crystals, in which it is pleasant to see that Dr. Desch gives full credit to the marvellously detailed work of Lehmann, who has now established it beyond doubt that there are substances, usually organic, which unite the properties of a crystal and a liquid, and that a definite arrangement of the molecules may persist in the liquid state.

The influence of surface tension is then discussed, and the existence of a metastable limit in the case of undercooling, together with the phenomenon of change of volume on solidification. Finally, the possibility of a thrust being exerted by growing crystals is debated from the evidence available, and the fact pointed out that there is yet no clear evidence of any effect which cannot be attributed to change of volume during change of state. The net result of the report is to indicate the immense field open for investigation, and one which has bearings, not only on pure science, but on industrial problems of the greatest importance and magnitude.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

INAUGURAL ADDRESS BY PROF. WILLIAM BATESON, M.A., F.R.S., PRESIDENT.

PART II.—SYDNEY.

AT Melbourne I spoke of the new knowledge of the properties of living things which Mendelian analysis has brought us. I indicated how these discoveries are affecting our outlook on that old problem of natural history, the origin and nature of species, and the chief conclusion I drew was the negative one, that, though we must hold to our faith in the evolution of species, there is little evidence as to how it has come about, and no clear proof that the process is continuing in any considerable degree at the present time. The thought uppermost in our minds is that knowledge of the nature of life is altogether too slender to warrant speculation on these fundamental subjects. Did we presume to offer such speculations they would have no more value than those which alchemists might have made as to the nature of the elements. But though in regard to these theoretical aspects we must confess to such deep ignorance, enough has been learnt of the general course of heredity within a single species to justify many practical conclusions which cannot in the main be shaken. I propose now to develop some of these conclusions in regard to our own species, Man.

In my former Address I mentioned the condition of certain animals and plants which are what we call "polymorphic." Their populations consist of individuals of many types, though they breed freely together with perfect fertility. In cases of this kind which have been sufficiently investigated it has been found that these distinctions—sometimes very great and affecting most diverse features of organisation—are due to the presence or absence of elements, or factors as we call them, which are treated in heredity as separate entities. These factors and their combinations produce the characteristics which we perceive. No individual can acquire a particular characteristic unless the requisite factors entered into the composition of that individual at fertilisation, being received either from the father or from the mother or from both, and consequently no individual can pass on to his offspring positive characters which he does not himself possess. Rules of this kind have already been traced in operation in the human species; and though I admit that an assumption of some magnitude is involved when we extend the application of the same system to human characteristics in general, yet the assumption is one which I believe we are fully justified in making. With little hesitation we can now declare that the potentialities and aptitudes, physical as well as mental, sex, colours, powers of work or invention, liability to diseases, possible duration of life, and the other features by which the members of a mixed population differ from each other, are determined from the moment of fertilisation; and by all that we know of heredity in the forms of life with which we can experiment we are compelled to believe that these qualities are in the main distributed on a factorial system. By changes in the outward conditions of life the expression of some of these powers and features may be excited or restrained. For the development of some an external opportunity is needed, and if that be withheld the character is never seen, any more than if the body be starved can the full height be attained; but such influences are superficial and do not alter the genetic constitution.

The factors which the individual receives from his parents and no others are those which he can transmit to his offspring; and if a factor was received from one parent only, not more than half the offspring, on an average, will inherit it. What is it that has so long prevented mankind from discovering such simple facts? Primarily the circumstance that as man must have *two* parents it is not possible quite easily to detect the contributions of each. The individual body is a *double* structure, whereas the germ-cells are *single*. Two germ-cells unite to produce each individual body, and the ingredients they respectively contribute interact in ways that leave the ultimate product a medley in which it is difficult to identify the several ingredients. When, however, their effects are conspicuous the task is by no means impossible. In part also even physiologists have been blinded by the survival of ancient and obscurantist

conceptions of the nature of man by which they were discouraged from the application of any rigorous analysis. Medical literature still abounds with traces of these archaisms, and, indeed, it is only quite recently that prominent horse-breeders have come to see that the dam matters as much as the sire. For them, though vast pecuniary considerations were involved, the old "homunculus" theory was good enough. We were amazed at the notions of genetic physiology which Prof. Baldwin Spencer encountered in his wonderful researches among the natives of Central Australia; but in truth, if we reflect that these problems have engaged the attention of civilised man for ages, the fact that he, with all his powers of recording and deduction, failed to discover any part of the Mendelian system is almost as amazing. The popular notion that any parents can have any kind of children within the racial limits is contrary to all experience, yet we have gravely entertained such ideas. As I have said elsewhere, the truth might have been found out at any period in the world's history if only pedigrees had been drawn the right way up. If, instead of exhibiting the successive pairs of progenitors who have contributed to the making of an ultimate individual, some one had had the idea of setting out the posterity of a single ancestor who possessed a marked feature such as the Habsburg lip, and showing the transmission of this feature along some of the descending branches and the permanent loss of the feature in collaterals, the essential truth that heredity can be expressed in terms of presence and absence must have at once become apparent. For the descendant is not, as he appears in the conventional pedigree, a sort of pool into which each tributary ancestral stream has poured something, but rather a conglomerate of ingredient-characters taken from his progenitors in such a way that some ingredients are represented and others are omitted.

Let me not, however, give the impression that the unravelling of such descents is easy. Even with fairly full details, which in the case of man are very rarely to be had, many complications occur, often preventing us from obtaining more than a rough general indication of the system of descent. The nature of these complications we partly understand from our experience of animals and plants which are amenable to breeding under careful restrictions, and we know that they are mostly referable to various effects of interaction between factors by which the presence of some is masked.

Necessarily the clearest evidence of regularity in the inheritance of human characteristics has been obtained in regard to the descent of marked abnormalities of structure and congenital diseases. Of the descent of ordinary distinctions such as are met with in the normal healthy population we know little for certain. Hurst's evidence, that two parents both with light-coloured eyes—in the strict sense, meaning that no pigment is present on the front of the iris—do not have dark-eyed children, still stands almost alone in this respect. With regard to the inheritance of other colour-characteristics some advance has been made, but everything points to the inference that the genetics of colour and many other features in man will prove exceptionally complex. There are, however, plenty of indications of system comparable with those which we trace in various animals and plants, and we are assured that to extend and clarify such evidence is only a matter of careful analysis. For the present, in asserting almost any general rules for human descent, we do right to make large reservations for possible exceptions. It is tantalising to have to wait, but of the ultimate result there can be no doubt.

I spoke of complications. Two of these are worth illustrating here, for probably both of them play a great part in human genetics. It was discovered by Nilsson-Ehle, in the course of experiments with certain wheats, that several factors having the same power may co-exist in the same individual. These cumulative factors do not necessarily produce a cumulative effect, for any one of them may suffice to give the full result. Just as the pure-bred tall pea with its two factors for tallness is no taller than the cross-bred with a single factor, so these wheats with three pairs of factors for red colour are no redder than the ordinary reds of the same family. Similar observations have been made by East and others. In some cases, as in the Primulas studied by Gregory, the effect is cumulative. These results have been used with plausibility by Davenport and the American workers to elucidate the curious case of the mulatto. If the descent of colour in the cross between the negro and the white man followed the simplest rule, the offspring of two first-cross mulattos would be, on an average, one black: two mulattos: one white, but this is notoriously not so. Evidence of some segregation is fairly clear, and the deficiency of real whites may perhaps be accounted for on the hypothesis of cumulative factors, though by the nature of the case strict proof is not to be had. But at present I own to a preference for regarding such examples as instances of imperfect segregation. The series of germ-cells produced by the cross-bred consists of some with no black, some with full black, and others with intermediate quantities of black. No statistical tests of the condition of the gametes in such cases exist, and it is likely that by choosing suitable crosses all sorts of conditions may be found, ranging from the simplest case of total segregation, in which there are only two forms of gametes, up to those in which there are all intermediates in various proportions. This at least is what general experience of hybrid products leads me to anticipate. Segregation is somehow effected by the rhythms of cell-division, if such an expression may be permitted. In some cases the whole factor is so easily separated that it is swept out at once; in others it is so intermixed that gametes of all degrees of purity may result. That is admittedly a crude metaphor, but as yet we cannot substitute a better. Be all this as it may, there are many signs that in human heredity phenomena of this kind are common, whether they indicate a multiplicity of cumulative factors or imperfections in segregation. Such phenomena, however, in no way detract from the essential truths that segregation occurs, and that the organism cannot pass on a factor which it has not itself received.

In human heredity we have found some examples, and I believe that we shall find many more, in which the descent of factors is limited by sex. The classical instances are those of colour-blindness and hæmophilia. Both these conditions occur with much greater frequency in males than in females. Of colour-blindness at least we know that the *sons* of the colour-blind man do not inherit it (unless the mother is a transmitter) and do not transmit it to their children of either sex. Some, probably all, of the daughters of the colour-blind father inherit the character, and though not themselves colour-blind, they transmit it to some (probably, on an average, half) of their offspring of both sexes. For since these normal-sighted women have only received the colour-blindness from one side of their parentage, only half their offspring, on an average, can inherit it. The sons who inherit the colour-blindness will be colour-blind, and the inheriting daughters become themselves again transmitters. Males with normal colour-vision,

whatever their own parentage, do not have colour-blind descendants, unless they marry transmitting women. There are points still doubtful in the interpretation, but the critical fact is clear, that the germ-cells of the colour-blind man are of two kinds: (i) those which do not carry on the affection and are destined to take part in the formation of sons; and (ii) those which do carry on the colour-blindness and are destined to form daughters. There is evidence that the ova also are similarly predestined to form one or other of the sexes, but to discuss the whole question of sex-determination is beyond my present scope. The descent of these sex-limited affections nevertheless calls for mention here, because it is an admirable illustration of factorial predestination. It moreover exemplifies that *parental polarity* of the zygote to which I alluded in my first Address, a phenomenon which we suspect to be at the bottom of various anomalies of heredity, and suggests that there may be truth in the popular notion that in some respects sons resemble their mothers and daughters their fathers.

As to the descent of hereditary diseases and malformations, however, we have abundant data for deciding that many are transmitted as dominants and a few as recessives. The most remarkable collection of these data is to be found in family histories of diseases of the eye. Neurology and dermatology have also contributed many very instructive pedigrees. In great measure the ophthalmological material was collected by Edward Nettleship, for whose death we so lately grieved. After retiring from practice as an oculist he devoted several years to this most laborious task. He was not content with hearsay evidence, but travelled incessantly, personally examining all accessible members of the families concerned, working in such a way that his pedigrees are models of orderly observation and recording. His zeal stimulated many younger men to take part in the work, and it will now go on, with the result that the systems of descent of all the common hereditary diseases of the eye will soon be known with approximate accuracy.

Give a little imagination to considering the chief deduction from this work. Technical details apart, and granting that we cannot wholly interpret the numerical results, sometimes noticeably more and sometimes fewer descendants of these patients being affected than Mendelian formulæ would indicate, the expectation is that in the case of many diseases of the eye a large proportion of the children, grandchildren, and remoter descendants of the patients will be affected with the disease. Sometimes it is only defective sight that is transmitted; in other cases it is blindness, either from birth or coming on at some later age. The most striking example perhaps is that of a form of night-blindness still prevalent in a district near Montpellier, which has affected at least 130 persons, all descending from a single affected individual[1] who came into the country in the seventeenth century. The transmission is in every case through an affected parent, and no normal has been known to pass on the condition. Such an example well serves to illustrate the fixity of the rules of descent. Similar instances might be recited relating to a great variety of other conditions, some trivial, others grave.

At various times it has been declared that men are born equal, and that the inequality is brought about by unequal opportunities. Acquaintance with the pedigrees of disease soon shows the fatuity of such fancies. The same conclusion, we may be sure, would result from the true representation of the descent of any human faculty. Never since Galton's publications can the matter have been in any doubt. At the time he began to study family histories even the broad significance of heredity was frequently denied, and resemblances to parents or ancestors were looked on as interesting curiosities. Inveighing against hereditary political institutions, Tom Paine remarks that the idea is as absurd as that of an "hereditary wise man," or an "hereditary mathematician," and to this day I suppose many people are not aware that he is saying anything more than commonly foolish. We, on the contrary, would feel it something of a puzzle if two parents, both mathematically gifted, had any children *not* mathematicians. Galton first demonstrated the overwhelming importance of these considerations, and had he not been misled, partly by the theory of pangenesis, but more by his mathematical instincts and training, which prompted him to apply statistical treatment rather than qualitative analysis, he might, not improbably, have discovered the essential facts of Mendelism.

It happens rarely that science has anything to offer to the common stock of ideas at once so comprehensive and so simple that the courses of our thoughts are changed. Contributions to the material progress of mankind are comparatively frequent. They result at once in application. Transit is quickened; communication is made easier; the food-supply is increased and population multiplied. By direct application to the breeding of animals and plants such results must even flow from Mendel's work. But I imagine the greatest practical change likely to ensue from modern genetic discovery will be a quickening of interest in the true nature of man and in the biology of races. I have spoken cautiously as to the evidence for the operation of any simple Mendelian system in the descent of human faculty; yet the certainty that systems which differ from the simpler schemes only in degree of complexity are at work in the distribution of characters among the human population cannot fail to influence our conceptions of life and of ethics, leading perhaps ultimately to modification of social usage. That change cannot but be in the main one of simplification. The eighteenth century made great pretence of a return to nature, but it did not occur to those philosophers first to inquire what nature is; and perhaps not even the patristic writings contain fantasies much further from physiological truth than those which the rationalists of the "Encyclopædia" adopted as the basis of their social schemes. For men are so far from being born equal or similar that to the naturalist they stand as the very type of a polymorphic species. Even most of our local races consist of many distinct strains and individual types. From the population of any ordinary English town as many distinct human breeds could in a few generations be isolated as there are now breeds of dogs, and indeed such a population in its present state is much what the dogs of Europe would be in ten years' time but for the interference of the fanciers. Even as at present constituted, owing to the isolating effects of instinct, fashion, occupation, and social class, many incipient strains already exist.

In one respect civilised man differs from all other species of animal or plant in that, having prodigious and ever-increasing power over nature, he invokes these powers for the preservation and maintenance of many of the inferior and all the defective members of his species. The inferior freely multiply, and the defective, if their defects be not so grave as to lead to their detention in prisons or asylums, multiply also without restraint. Heredity being strict in its action,

[1] The first human descent proved to follow Mendelian rules was that of a serious malformation of the hand studied by Farabee in America. Drinkwater subsequently worked out pedigrees for the same malformation in England. After many attempts, he now tells me that he has succeeded in proving that the American family and one of his own had an abnormal ancestor in common, five generations ago.

the consequences are in civilised countries much what they would be in the kennels of the dog-breeder who continued to preserve all his puppies, good and bad: the proportion of defectives increases. The increase is so considerable that outside every great city there is a smaller town inhabited by defectives and those who wait on them. Round London we have a ring of such towns with some 30,000 inhabitants, of whom about 28,000 are defective, largely, though of course by no means entirely, bred from previous generations of defectives. Now, it is not for us to consider practical measures. As men of science we observe natural events and deduce conclusions from them. I may perhaps be allowed to say that the remedies proposed in America, in so far as they aim at the eugenic regulation of marriage on a comprehensive scale, strike me as devised without regard to the needs either of individuals or of a modern State. Undoubtedly if they decide to breed their population of one uniform puritan grey, they can do it in a few generations; but I doubt if timid respectability will make a nation happy, and I am sure that qualities of a different sort are needed if it is to compete with more vigorous and more varied communities. Everyone must have a preliminary sympathy with the aims of eugenists both abroad and at home. Their efforts at the least are doing something to discover and spread truth as to the physiological structure of society. The spirit of such organisations, however, almost of necessity suffers from a bias towards the accepted and the ordinary, and if they had power it would go hard with many ingredients of society that could be ill-spared. I notice an ominous passage in which even Galton, the founder of eugenics, feeling perhaps some twinge of his Quaker ancestry, remarks that "as the Bohemianism in the nature of our race is destined to perish, the sooner it goes, the happier for mankind." It is not the eugenists who will give us what Plato has called divine releases from the common ways. If some fancier with the catholicity of Shakespeare would take us in hand, well and good; but I would not trust even Shakespeares meeting as a committee. Let us remember that Beethoven's father was an habitual drunkard and that his mother died of consumption. From the genealogy of the patriarchs also we learn—what may very well be the truth—that the fathers of such as dwell in tents, and of all such as handle the harp or organ, and the instructor of every artificer in brass and iron—the founders, that is to say, of the arts and the sciences—came in direct descent from Cain, and not in the posterity of the irreproachable Seth, who is to us, as he probably was also in the narrow circle of his own contemporaries, what naturalists call a *nomen nudum*.

Genetic research will make it possible for a nation to elect by what sort of beings it will be represented not very many generations hence, much as a farmer can decide whether his byres shall be full of shorthorns or Herefords. It will be very surprising indeed if some nation does not make trial of this new power. They may make awful mistakes, but I think they will try.

Whether we like it or not, extraordinary and far-reaching changes in public opinion are coming to pass. Man is just beginning to know himself for what he is—a rather long-lived animal, with great powers of enjoyment if he does not deliberately forgo them. Hitherto superstition and mythical ideas of sin have predominantly controlled these powers. Mysticism will not die out: for those strange fancies knowledge is no cure; but their forms may change, and mysticism as a force for the suppression of joy is happily losing its hold on the modern world. As in the decay of earlier religions Ushabti dolls were substituted for human victims, so telepathy, necromancy, and other harmless toys take the place of eschatology and the inculcation of a ferocious moral code. Among the civilised races of Europe we are witnessing an emancipation from traditional control in thought, in art, and in conduct which is likely to have prolonged and wonderful influences. Returning to freer or, if you will, simpler conceptions of life and death, the coming generations are determined to get more out of this world than their forefathers did. Is it then to be supposed that when science puts into their hand means for the alleviation of suffering immeasurable, and for making this world a happier place, that they will demur to using those powers? The intenser struggle between communities is only now beginning, and with the approaching exhaustion of that capital of energy stored in the earth before man began it must soon becomes still more fierce. In England some of our great-grandchildren will see the end of the easily accessible coal, and, failing some miraculous discovery of available energy, a wholesale reduction in population. There are races who have shown themselves able at a word to throw off all tradition and take into their service every power that science has yet offered them. Can we expect that they, when they see how to rid themselves of the ever-increasing weight of a defective population, will hesitate? The time cannot be far distant when both individuals and communities will begin to think in terms of biological fact, and it behoves those who lead scientific thought carefully to consider whither action should lead. At present I ask you merely to observe the facts. The powers of science to preserve the defective are now enormous. Every year these powers increase. This course of action must reach a limit. To the deliberate intervention of civilisation for the preservation of inferior strains there must sooner or later come an end, and before long nations will realise the responsibility they have assumed in multiplying these "cankers of a calm world and a long peace."

The definitely feeble-minded we may with propriety restrain, as we are beginning to do even in England, and we may safely prevent unions in which both parties are defective, for the evidence shows that as a rule such marriages, though often prolific, commonly produce no normal children at all. The union of such social vermin we should no more permit than we would allow parasites to breed on our own bodies. Further than that in restraint of marriage we ought not to go, at least not yet. Something too may be done by a reform of medical ethics. Medical students are taught that it is their duty to prolong life at whatever cost in suffering. This may have been right when diagnosis was uncertain and interference usually of small effect; but deliberately to interfere now for the preservation of an infant so gravely diseased that it can never be happy or come to any good is very like wanton cruelty. In private few men defend such interference. Most who have seen these cases lingering on agree that the system is deplorable, but ask where can any line be drawn. The biologist would reply that in all ages such decisions have been made by civilised communities with fair success both in regard to crime and in the closely analogous case of lunacy. The real reason why these things are done is because the world collectively cherishes occult views of the nature of life, because the facts are realised by few, and because between the legal mind—to which society has become accustomed to defer—and the seeing eye, there is such physiological antithesis that scarcely can they be combined in the same body. So soon as scientific knowledge becomes common property, views more reasonable and, I may add, more humane, are likely to prevail.

To all these great biological problems that modern society must sooner or later face there are many

aspects besides the obvious ones. Infant mortality we are asked to lament without the slightest thought of what the world would be like if the majority of these infants were to survive. The decline in the birth-rate in countries already over-populated is often deplored, and we are told that a nation in which population is not rapidly increasing must be in a decline. The slightest acquaintance with biology, or even school-boy natural history, shows that this inference may be entirely wrong, and that before such a question can be decided in one way or the other, hosts of considerations must be taken into account. In normal stable conditions population is stationary. The laity never appreciates, what is so clear to a biologist, that the last century and a quarter, corresponding with the great rise in population, has been an altogether exceptional period. To our species this period has been what its early years in Australia were to the rabbit. The exploitation of energy-capital of the earth in coal, development of the new countries, and the consequent pouring of food into Europe, the application of antiseptics, these are the things that have enabled the human population to increase. I do not doubt that if population were more evenly spread over the earth it might increase very much more; but the essential fact is that under any stable conditions a limit must be reached. A pair of wrens will bring off a dozen young every year, but each year you will find the same number of pairs in your garden. In England the limit beyond which under present conditions of distribution increase of population is a source of suffering rather than of happiness has been reached already. Younger communities living in territories largely vacant are very probably right in desiring and encouraging more population. Increase, may, for some temporary reason, be essential to their prosperity. But those who live, as I do, among thousands of creatures in a state of semi-starvation will realise that too few is better than too many, and will acknowledge the wisdom of Ecclesiasticus who said "Desire not a multitude of unprofitable children."

But at least it is often urged that the decline in the birth-rate of the intelligent and successful sections of the population—I am speaking of the older communities—is to be regretted. Even this cannot be granted without qualification. As the biologist knows, differentiation is indispensable to progress. If population were homogeneous civilisation would stop. In every army the officers must be comparatively few. Consequently, if the upper strata of the community produce more children than will recruit their numbers some must fall into the lower strata and increase the pressure there. Statisticians tell us that an average of four children under present conditions is sufficient to keep the number constant, and as the expectation of life is steadily improving we may perhaps contemplate some diminution of that number without alarm.

In the study of history biological treatment is only beginning to be applied. For us the causes of the success and failure of races are physiological events, and the progress of man has depended upon a chain of these events, like those which have resulted in the "improvement" of the domesticated animals and plants. It is obvious, for example, that had the cereals never been domesticated cities could scarcely have existed. But we may go further, and say that in temperate countries of the Old World (having neither rice nor maize) populations concentrated in large cities have been made possible by the appearance of a "thrashable" wheat. The ears of the wild wheats break easily to pieces, and the grain remains in the thick husk. Such wheat can be used for food, but not readily. Ages before written history began, in some unknown place, plants, or more likely a plant, of wheat lost the dominant factor to which this brittleness is due, and the recessive, thrashable wheat resulted. Some man noticed this wonderful novelty, and it has been disseminated over the earth. The original variation may well have occurred once only, in a single germ-cell.

So must it have been with Man. Translated into terms of factors, how has that progress in control of nature which we call civilisation been achieved? By the sporadic appearance of variations, mostly, perhaps all, consisting in a loss of elements, which inhibit the free working of the mind. The members of civilised communities, when they think about such things at all, imagine the process a gradual one, and that they themselves are active agents in it. Few, however, contribute anything but their labour; and except in so far as they have freedom to adopt and imitate, their physiological composition is that of an earlier order of beings. Annul the work of a few hundreds—I might almost say scores—of men, and on what plane of civilisation should we be? We should not have advanced beyond the medieval stage without printing, chemistry, steam, electricity, or surgery worthy the name. These things are the contributions of a few excessively rare minds. Galton reckoned those to whom the term "illustrious" might be applied as one in a million, but in that number he is, of course, reckoning men famous in ways which add nothing to universal progress. To improve by subordinate invention, to discover details missed, even to apply knowledge never before applied, all these things need genius in some degree, and are far beyond the powers of the average man of our race; but the true pioneer, the man whose penetration creates a new world, as did that of Newton and of Pasteur, is inconceivably rare. But for a few thousands of such men, we should perhaps be in the Palæolithic era, knowing neither metals, writing, arithmetic, weaving, nor pottery.

In the history of art the same is true, but with this remarkable difference, that not only are gifts of artistic creation very rare, but even the faculty of artistic enjoyment, not to speak of higher powers of appreciation, is not attained without variation from the common type. I am speaking, of course, of the non-Semitic races of modern Europe, among whom the power whether of making or enjoying works of art is confined to an insignificant number of individuals. Appreciation can in some degree be simulated, but in our population there is no widespread physiological appetite for such things. When detached from the centres where they are made by others most of us pass our time in great contentment, making nothing that is beautiful, and quite unconscious of any deprivation. Musical taste is the most notable exception, for in certain races—for example, the Welsh and some of the Germans—it is almost universal. Otherwise artistic faculty is still sporadic in its occurrence. The case of music well illustrates the application of genetic analysis to human faculty. No one disputes that musical ability is congenital. In its fuller manifestation it demands sense of rhythm, ear, and special nervous and muscular powers. Each of these is separable and doubtless genetically distinct. Each is the consequence of a special departure from the common type. Teaching and external influences are powerless to evoke these faculties, though their development may be assisted. The only conceivable way in which the people of England, for example, could become a musical nation would be by the gradual rise in the proportional

numbers of a musical strain or strains until the present type became so rare as to be negligible. It by no means follows that in any other respect the resulting population would be distinguishable from the present one. Difficulties of this kind beset the efforts of anthropologists to trace racial origins. It must continually be remembered that most characters are independently transmitted and capable of such recombination. In the light of Mendelian knowledge the discussion whether a race is pure or mixed loses almost all significance. A race is pure if it breeds pure and not otherwise. Historically we may know that a race like our own was, as a matter of fact, of mixed origin. But a character may have been introduced by a single individual, though subsequently it becomes common to the race. This is merely a variant on the familiar paradox that in the course of time if registration is accurate we shall all have the same surname. In the case of music, for instance, the gift, originally perhaps from a Welsh source, might permeate the nation, and the question would then arise whether the nation, so changed, was the English nation or not.

Such a problem is raised in a striking form by the population of modern Greece, and especially of Athens. The racial characteristics of the Athenian of the fifth century B.C. are vividly described by Galton in "Hereditary Genius." The fact that in that period a population, numbering many thousands, should have existed, capable of following the great plays at a first hearing, revelling in subtleties of speech, and thrilling with passionate delight in beautiful things, is physiologically a most singular phenomenon. On the basis of the number of illustrious men produced by that age Galton estimated the average intelligence as at least two of his degrees above our own, differing from us as much as we do from the negro. A few generations later the display was over. The origin of that constellation of human genius which then blazed out is as yet beyond all biological analysis, but I think we are not altogether without suspicion of the sequence of the biological events. If I visit a poultry-breeder who has a fine stock of thoroughbred game fowls breeding true, and ten years later—that is to say ten fowl-generations later—I go again and find scarcely a recognisable game-fowl on the place, I know exactly what has happened. One or two birds of some other or of no breed must have strayed in and their progeny been left undestroyed. Now in Athens we have many indications that up to the beginning of the fifth century so long as the phratries and gentes were maintained in their integrity there was rather close endogamy, a condition giving the best chance of producing a homogeneous population. There was no lack of material from which intelligence and artistic power might be derived. Sporadically these qualities existed throughout the ancient Greek world from the dawn of history, and, for example, the vase-painters, the makers of the Tanagra figurines, and the gem-cutters were presumably pursuing family crafts, much as are the actor-families[2] of England or the professorial families of Germany at the present day. How the intellectual strains should have acquired predominance we cannot tell, but in an in-breeding community homogeneity at least is not surprising. At the end of the sixth century came the "reforms" of Cleisthenes (507 B.C.), which sanctioned foreign marriages and admitted to citizenship a number not only of resident aliens but also of manumitted slaves. As Aristotle says, Cleisthenes legislated with the deliberate purpose of breaking up the phratries and gentes, in order that the various sections of the population might be mixed up as much as possible, and the old tribal associations abolished. The "reform" was probably a recognition and extension of a process already begun; but is it too much to suppose that we have here the effective beginning of a series of genetic changes which in a few generations so greatly altered the character of the people? Under Pericles the old law was restored (451 B.C.), but losses in the great wars led to further laxity in practice, and though at the end of the fifth century the strict rule was re-enacted that a citizen must be of citizen-birth on both sides, the population by that time may well have become largely mongrelised.

Let me not be construed as arguing that mixture of races is an evil: far from it. A population like our own, indeed, owes much of its strength to the extreme diversity of its components, for they contribute a corresponding abundance of aptitudes. Everything turns on the nature of the ingredients brought in, and I am concerned solely with the observation that these genetic disturbances lead ultimately to great and usually unforeseen changes in the nature of the population.

Some experiments of this kind are going on at the present time, in the United States, for example, on a very large scale. Our grand-children may live to see the characteristics of the American population entirely altered by the vast invasion of Italian and other South European elements. We may expect that the Eastern States, and especially New England, the people of which still exhibit the fine Puritan qualities with their appropriate limitations, absorbing little of the alien elements, will before long be in feelings and aptitudes very notably differentiated from the rest. In Japan, also, with the abolition of the feudal system and the rise of commercialism, a change in population has begun which may be worthy of the attention of naturalists in that country. Till the revolution the Samurai almost always married within their own class, with the result, as I am informed, that the caste had fairly recognisable features. The changes of 1868 and the consequent impoverishment of the Samurai have brought about a beginning of disintegration which may not improbably have perceptible effects.

How many genetic vicissitudes has our own peerage undergone! Into the hard-fighting stock of medieval and Plantagenet times have successively been crossed the cunning shrewdness of Tudor statesmen and courtiers, the numerous contributions of Charles II. and his concubines, reinforcing peculiar and persistent attributes which popular imagination especially regards as the characteristic of peers, ultimately the heroes of finance and industrialism. Definitely intellectual elements have been sporadically added, with rare exceptions, however, from the ranks of lawyers and politicians. To this aristocracy art, learning, and science have contributed sparse ingredients, but these mostly chosen for celibacy or childlessness. A remarkable body of men, nevertheless; with an average "horse-power," as Samuel Butler would have said, far exceeding that of any random sample of the middle-class. If only man could be reproduced by budding what a simplification it would be! In vegetative reproduction heredity is usually complete. The Washington plum can be divided to produce as many identical individuals as are required. If, say, Washington, the statesman, or preferably King Solomon, could similarly have been propagated, all the nations of the earth could have been supplied with ideal rulers.

Historians commonly ascribe such changes as occurred in Athens, and will almost certainly come

[2] For tables of these families, see the Supplement to "Who's Who in the Theatre."

to pass in the United States, to conditions of life and especially to political institutions. These agencies, however, do little unless they are such as to change the breed. External changes may indeed give an opportunity to special strains, which then acquire ascendency. The industrial developments which began at the end of the eighteenth century, for instance, gave a chance to strains till then submerged, and their success involved the decay of most of the old aristocratic families. But the demagogue who would argue from the rise of the one and the fall of the other that the original relative positions were not justifiable altogether mistakes the facts.

Conditions give opportunities but cause no variations. For example, in Athens, to which I just referred, the universality of cultivated discernment could never have come to pass but for the institution of slavery which provided the opportunity, but slavery was in no sense a cause of that development, for many other populations have lived on slaves and remained altogether inconspicuous.

The long-standing controversy as to the relative importance of nature and nurture, to use Galton's "convenient jingle of words," is drawing to an end, and of the overwhelmingly greater significance of nature there is no longer any possibility of doubt. It may be well briefly to recapitulate the arguments on which naturalists rely in coming to this decision both as regards races and individuals. First as regards human individuals, there is the common experience that children of the same parents reared under conditions sensibly identical may develop quite differently, exhibiting in character and aptitudes a segregation just as great as in their colours or hair-forms. Conversely all the more marked aptitudes have at various times appeared and not rarely reached perfection in circumstances the least favourable for their development. Next, appeal can be made to the universal experience of the breeder, whether of animals or plants, that strain is absolutely essential, that though bad conditions may easily enough spoil a good strain, yet that under the best conditions a bad strain will never give a fine result. It is faith, not evidence, which encourages educationists and economists to hope so greatly in the ameliorating effects of the conditions of life. Let us consider what they can do and what they cannot. By reference to some sentences in a charming though pathetic book, "What Is, and What Might Be," by Mr. Edmond Holmes, which will be well known in the Educational Section, I may make the point of view of us naturalists clear. I take Mr. Holmes's pronouncement partly because he is an enthusiastic believer in the efficacy of nurture as opposed to nature, and also because he illustrates his views by frequent appeals to biological analogies which help us to a common ground. Wheat badly cultivated will give a bad yield, though, as Mr. Holmes truly says, wheat of the same strain in similar soil well cultivated may give a good harvest. But, having witnessed the success of a great natural teacher in helping unpromising peasant children to develop their natural powers, he gives us another botanical parallel. Assuming that the wild bullace is the origin of domesticated plums, he tells us that by cultivation the bullace can no doubt be improved so far as to become a better bullace, but by no means can the bullace be made to bear plums.

All this is sound biology; but translating these facts into the human analogy, he declares that the work of the successful teacher shows that with man the facts are otherwise, and that the *average* rustic child, whose normal ideal is "bullacehood," can become the rare exception, developing to a stage corresponding with that of the plum. But the naturalist knows exactly where the parallel is at fault. For the wheat and the bullace are both breeding approximately true, whereas the human crop, like jute and various cottons, is in a state of polymorphic mixture. The population of many English villages may be compared with the crop which would result from sowing a bushel of kernels gathered mostly from the hedges, with an occasional few from an orchard. If anyone asks how it happens that there are any plum-kernels in the sample at all, he may find the answer perhaps in spontaneous variation, but more probably in the appearance of a long-hidden recessive. For the want of that genetic variation, consisting probably, as I have argued, in loss of inhibiting factors, by which the plum arose from the wild form, neither food, nor education, nor hygiene can in any way atone. Many wild plants are half-starved through competition, and transferred to garden soil they grow much bigger; so good conditions might certainly enable the bullace population to develop beyond the stunted physical and mental stature they commonly attain, but plums they can never be. Modern statesmanship aims rightly at helping those who have got sown as wildings to come into their proper class; but let not anyone suppose such a policy democratic in its ultimate effects, for no course of action can be more effective in strengthening the upper classes whilst weakening the lower.

In all practical schemes for social reform the congenital diversity, the essential polymorphism of all civilised communities must be recognised as a fundamental fact, and reformers should rather direct their efforts to facilitating and rectifying class-distinctions than to any futile attempt to abolish them. The teaching of biology is perfectly clear. We are what we are by virtue of our differentiation. The value of civilisation has in all ages been doubted. Since, however, the first variations were not strangled in their birth, we are launched on that course of variability of which civilisation is the consequence. We cannot go back to homogeneity again, and differentiated we are likely to continue. For a period measures designed to create a spurious homogeneity may be applied. Such attempts will, I anticipate, be made when the present unstable social state reaches a climax of instability, which may not be long hence. Their effects can be but evanescent. The instability is due not to inequality, which is inherent and congenital, but rather to the fact that in periods of rapid change like the present, convection-currents are set up such that the elements of the strata get intermixed and the apparent stratification corresponds only roughly with the genetic. In a few generations under uniform conditions these elements settle in their true levels once more.

In such equilibrium is content most surely to be expected. To the naturalist the broad lines of solution of the problems of social discontent are evident. They lie neither in vain dreams of a mystical and disintegrating equality, nor in the promotion of that malignant individualism which in older civilisations has threatened mortification of the humbler organs, but rather in a physiological co-ordination of the constituent parts of the social organism. The rewards of commerce are grossly out of proportion to those attainable by intellect or industry. Even regarded as compensation for a dull life, they far exceed the value of the services rendered to the community. Such disparity is an incident of the abnormally rapid growth of population and is quite indefensible as a permanent social condition. Nevertheless, capital, distinguished as a provision for offspring, is a eugenic institution; and unless human instinct undergoes some profound and improbable variation, abolition of

capital means the abolition of effort; but as in the body the power of independent growth of the parts is limited and subordinated to the whole, similarly in the community we may limit the powers of capital, preserving so much inequality of privilege as corresponds with physiological fact.

At every turn the student of political science is confronted with problems that demand biological knowledge for their solution. Most obviously is this true in regard to education, the criminal law, and all those numerous branches of policy and administration which are directly concerned with the physiological capacities of mankind. Assumptions as to what can be done and what cannot be done to modify individuals and races have continually to be made, and the basis of fact on which such decisions are founded can be drawn only from biological study.

A knowledge of the facts of nature is not yet deemed an essential part of the mental equipment of politicians; but as the priest, who began in other ages as medicine-man, has been obliged to abandon the medical parts of his practice, so will the future behold the schoolmaster, the magistrate, the lawyer, and ultimately the statesman, compelled to share with the naturalist those functions which are concerned with the physiology of race.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. WILLIAM J. POPE, M.A., LL.D., F.R.S., PRESIDENT OF THE SECTION.

(*Concluded from p. 649.*)

THE two assemblages can now be described in a quantitative manner by stating the symmetry and also the relative dimensions of each. The cubic assemblage exhibits symmetry identical with that of the cube or the regular octahedron, a symmetry characteristic of so-called holohedral cubic crystals; the relative dimensions in different directions are defined by the symmetry. The assemblage can, in fact, be referred to three axes parallel to the edges of a cube, and as these directions are obviously similar in a cube, their ratios are of the form, $a : b : c = 1 : 1 : 1$. This expression indicates that if the assemblage, supposed indefinitely extended through space, is moved by a unit distance in either of the three rectangular directions, a, b, and c, the effect, as examined from any point, is as if the assemblage had not been moved at all.

The symmetry of the hexagonal assemblage is identical with that of a hexagonal prism or of a double hexagonal pyramid, and is that characteristic of the so-called holohedral, hexagonal, crystalline system; the relative dimensions are no longer defined entirely by the symmetry, and are conveniently stated as the ratio of the diameter, a, of the prism or pyramid, to the height, c, of the pyramid. The ratio, $a : c$, for the assemblage of spheres under discussion can be calculated; it assumes two forms, corresponding to two modes of selecting alternative principal diameters of the prism as unit. The alternative ratios are: $a : c = 1 : 1{\cdot}6330$ or $a : c = 1 : 1{\cdot}4142$.

This somewhat lengthy theoretical discussion has now reached a stage at which it can be applied to the observed facts; the accompanying table (Table I.) states the mode in which crystalline substances of different degrees of molecular complexity distribute themselves amongst the various crystal systems. Of the elements which have been crystallographically examined, 50 per cent. are cubic, whilst a further 35 per cent. are hexagonal; and consideration of the data for these latter shows that they exhibit approximately the axial ratios characteristic of the hexagonal closest-packed assemblage; thus magnesium shows $a : c = 1 : 1{\cdot}6242$, and arsenic the ratio $a : c = 1{\cdot}4025$.

TABLE I.

System.	Inorganic substances, the number of atoms in the molecule of which is respectively: Elements: 2	3	4	5	More than 5	Organic Substances
	Per cent.					
Cubic	50	68·5	42	5	12	5·8	2·5
Hexagonal ..	35	19·5	11	35	38	14·6	4·0
Tetragonal ...	5	4·5	19	5	6	7	5·0
Orthorhombi: ...	5	3·0	23·5	50	36	27·3	34·0
Monosymmetric	5	4·5	3	5	6	37·3	47·5
Anorthic ...	0	0	1·5	0	2	8	7·0
No. of cases examined for each vertical column	140	67	63	20	50	673	585

Whilst the crystal structure of some 85 per cent. of the crystalline elements seems to be in general agreement with the simple assumption of equilibrium which has been made, the divergence presented by about 15 per cent. of the elements still awaits explanation. The previous discussion applies to the theoretically simple case of a monatomic element; many of the elements are, however, certainly polyatomic. Imagine, therefore, that in the crystal structure, agreeing with the cubic or hexagonal arrangement just described, the similar atoms are grouped to form complex molecules, each containing two or more atoms; the geometrical effect of this grouping, if any, should be, first, to degrade the symmetry of the structure, and, secondly, to slightly alter its relative dimensions. It would therefore be expected that if the elements which are neither cubic nor hexagonal owe their departure from those systems to molecular aggregation, the crystal dimensions should approximate closely to those of the two ideal assemblages; this is, indeed, found to be the case. Monosymmetric sulphur, for instance, exhibits the axial ratios, $a : b : c = 0{\cdot}9958 : 1 : 0{\cdot}9988$, $\beta = 95° 46'$; the relative dimensions in the three directions a, b, and c, are almost the same as in the cubic system, and the angle between the directions a and c is $\beta = 95° 46'$, instead of 90°. This substance has nearly the dimensions of a cubic crystal, and is obviously "pseudo-cubic"; the same is true of all other elements which depart from true cubic or hexagonal symmetry.

The crystalline forms presented by the elements are consequently in accordance with the assumption that the crystal structures are equilibrium arrangements of the component atoms of the two kinds described. It is also indicated that aggregation of the atoms to form molecular complexes is responsible for the departure from simple cubic or hexagonal symmetry; in this connection it is interesting to note that the strongly coloured elements depart most widely from these two systems. Thus, the colourless modifications of carbon and phosphorus are cubic, whilst the black graphite is monosymmetric and the red phosphorus is orthorhombic in crystal form; this is in accordance with the general view that colour is the result of some particular kind of molecular aggregation.

Although so much general correspondence of a quantitative character is to be observed between the observed facts and the anticipations developed from the equilibrium assumption, it has become evident during the last year or two that the conception formed

as to the nature of the equilibrium which determines the arrangement of the atoms in a crystalline element is of too simple a character. In 1912 Laue showed that on passing a narrow pencil of X-rays through a crystal plate the emergent rays were capable of forming a regular, geometrical pattern of spots upon a photographic plate placed to receive the emergent beam; the pattern of spots thus produced was in agreement with the symmetry of the direction in the crystal plate in which the beam was passed. This discovery was developed and very considerably extended by Bragg, who was able to show that an X-ray beam undergoes reflection at the surface of a crystal plate. The interpretation of the novel results indicates that the homogeneous crystal structure acts upon the X-ray beam much as a solid diffraction grating might be expected to do, and that each deflected transmitted ray is a reflection from one set of parallel planes of atoms in the crystal.

The experimental and theoretical study of the X-ray effects has been prosecuted with brilliant success by W. H. and W. L. Bragg, the result being that a method is now available which makes it possible to determine, with very great probability, the actual arrangement of the constituent atoms in crystal structure. Sufficient time has not yet elapsed for the thorough exploitation of this new and fruitful field of research, but many data are available already for comparison with the conclusions drawn from the consideration of the equilibria possible in crystal structures; it is found that the two methods do not at once lead to identical conclusions. Thus, in accordance with the first method, the structure of the diamond would be indicated at some slight modification of the cubic closest-packed assemblage of equal spheres, the modification consisting in the main of a grouping of sets of atoms which leads to the partial cubic symmetry which the diamond apparently exhibits; one particular mode of grouping which leads to the required result consists in supposing the carbon atoms formed into sets of four, tetrahedrally arranged, two oppositely orientated sets of such tetrahedral groups being distinguished. If each of these tetrahedral groups be replaced by a single point situated at the group-centre, the structure which the Bragg experiments indicate for the diamond is obtained.

The simple geometrical relationship which thus exists between the two suggested structures for diamond raises a suspicion that the particular form in which the assumption of equilibrium is stated requires qualification: that possibly the domain of the carbon atom when packed with others, as in the diamond, does not become converted into a rhombic dodecahedron, but into a polyhedron roughly tetrahedral in shape.

Leaving this particular point for the moment and turning again to Table I., it is seen that the binary compounds, like the elements, also tend to crystallise in the cubic or hexagonal systems; the axial ratios of the hexagonal binary compounds approximate very closely to the value, $a : c = 1 : 1{\cdot}6330$, calculated for the closest-packed, hexagonal assemblage of equal spheres. The values of c/a for all the known cases are: BeO – 1·6365, ZnO – 1·6077, ZnS – 1·6350, CdS – 1·6218, and AgI – 1·6392.

Assemblages representing the crystal structures of the cubic and hexagonal binary compounds may be derived from the two closest-packed assemblages of similar spheres already described, by homogeneously replacing one half of the spheres by different ones of the same size. The degrees of symmetry presented by these arrangements are not so high as those of the unsubstituted assemblages; this is in accordance with the fact that the crystals themselves have not the full symmetry of the holohedral cubic or hexagonal system. Thus, on warming a hexagonal crystal of silver iodide, one end of the principal axis c becomes positively, and the other negatively, electrified. The axis c is thus a polar axis, having different properties at its two ends; this axis will be found to be polar in the model. Again, when hexagonal silver iodide is heated to 145°, it changes its crystalline form and becomes cubic; this so-called polymorphous change can be imitated in the hexagonal model by slightly shifting each pair of layers of spheres in the assemblage.

A very close agreement thus exists between the properties of the assemblages deduced and the observed properties of those binary compounds which crystallise in the cubic or hexagonal systems. The remaining 12 per cent. or so are not, in general, pseudo-cubic or pseudo-hexagonal, and it is noteworthy that they comprise those binary compounds in which the two component elements have not the same lowest valency; amongst them are the substances of the compositions, PbO, FeAs, HgO, AsS, and CuO.

On comparing the structures of the binary crystalline compounds indicated by the foregoing method of consideration with those deduced by the Braggs, discrepancies are again obvious; again, however, the former assemblage is converted into the latter by replacing groups of spheres by their group-centres. The relation thus rendered apparent is once more a suggestion that the type of equilibrium conditions originally assumed is too simple. It will be seen, however, that the Bragg results furnish a proof of one part of the assumption made concerning equilibrium, namely, that each component atom operates separately; the discussion of the properties of crystals on the assumption that the crystal structure may be regarded as built up of similar mass-points, due to the mathematical physicists of the last century, therefore requires to be reopened. Thus, the Bragg structure of rock-salt is represented by dividing space into equal cubes by three sets of parallel planes and replacing the cube corners encountered along the directions of the cube edges by chlorine and sodium atoms alternately; each chlorine atom then has six sodium atoms as its nearest and equally distant neighbours. With which of the latter the one chlorine atom is associated to form a molecule of sodium chloride is not apparent from the nature of the crystal structure.

Time need not be now occupied with the further discussion of the crystalline structure of simple substances; until the discovery of the X-ray effects thus briefly described, no direct method of determining those structures was available, and, in view of the paucity of the experimental data, only the possibilities of arrangement could be considered in the light of the Barlow-Pope mode of treatment. It will, however, be useful to review some of the results which accrue from this latter method of regarding the problem of crystal structure in general.

Taking the general standpoint, which is also in accordance with the Bragg results, that each component atom of a crystalline structure has a separate spacial existence, and premising that the atomic domains are close-packed in the assemblage in accordance with some particular type of equilibrium law, it becomes obvious that crystalline structure presents a volume problem. The law arrived at after a careful investigation of the subject—the so-called law of valency volumes—states that in a crystalline structure, the component atoms occupy domains approximately proportional in volume to the numbers representing the fundamental valencies of the elements concerned; the student of the subject of molecular volumes will hardly accept this conclusion without convincing evi-

dence of its correctness—it indicates, for instance, that in crystalline potassium sulphate, if the atomic volume of potassium is taken as unity, those of sulphur and oxygen each have the value two. Many different lines of crystallographic argument converge, however, to this law, and, if the latter is in the end found to be incorrect, it at least represents something fundamental which still awaits enunciation in a more generally acceptable form. A few illustrative instances may be quoted.

If valency be a volume property, the relation should be revealed in the compositions of chemical substances, especially those of composite character. The sum of the valencies in potassium sulphate, K_2SO_4, is 12, and in ammonium sulphate, $(NH_4)_2SO_4$, 24, just twice the number; the two substances are so closely related that they crystallise together to form "solid solutions" (isomorphous mixtures. Similarly, in the alums, such as $K_2SO_4+Al_2(SO_4)_3+24H_2O$, the valencies are $12+36+96$; the sum of the valencies of the water present, 96, is just twice that, 48, of those exhibited by the metallic sulphates. Similar curious numerical relationships occur in each of the well-defined series of double salts.

Again, if the valency volume law hold for two substances of different crystalline form, such as orthorhombic rubidium nitrate, $RbNO_3$, and rhombohedral sodium nitrate, $NaNO_3$, the metal, the nitrogen and the oxygen in each compound should have the respective atomic volumes, 1, 3, and 2. As the substances differ in density the absolute values of the atomic volumes of nitrogen and oxygen will differ in the two substances as examined in the same temperature; the ratios of the atomic volumes in either compound should, however, be as stated. Considering this conclusion in conjunction with the fact that these crystalline compounds represent symmetrically constructed assemblages, it would seem that the relative dimensions of the one crystal structure should be traceable in those of the other. Orthorhombic rubidium nitrate exhibits the axial ratios, $a:b:c=1{\cdot}7336:1:0{\cdot}7106$, three rectangular coordinates, a, b, and c, being used as the directions of reference; rhombohedral sodium nitrate exhibits $a:c=1:0{\cdot}8276$, the coordinates being three axes, a, making angles of 120° in one plane, and a fourth axis c, perpendicular to a. On converting the axial system of sodium nitrate into a simple set of rectangular axes similar to those used for rubidium nitrate, the value, $a:c=1:0{\cdot}8276$, becomes

$$a:b:c=1{\cdot}7320:1:0{\cdot}7151.$$

These values approximate very closely to those obtained by direct measurement of the orthorhombic rubidium salt. It seems difficult to avoid the conclusion that the two dissimilar crystalline structures are built up by the arrangement of layers or blocks of the same relative dimensions in two different ways, the molecule of sodium nitrate, $NaNO_3$, possessing practically the same relative dimensions as that of rubidium nitrate, $RbNO_3$; this, of course, is in disaccord with the classic conception of atomic volume, but agrees entirely with the valency volume law.

Another remarkable body of evidence is found in the interpretation of many morphotropic relationships between organic and inorganic substances which have been long recognised but have hitherto eluded interpretation. The description of one or two cases will make the bearing of the law of valency volumes clear in this connection.

d-Camphoric anhydride, $C_{10}H_{14}O_3$, and *d*-camphoric acid crystallised with acetone, $C_{10}H_{16}O_4$, $1/2\,(CH_3)_2CO$, both crystallise in the orthorhombic system and exhibit the axial ratios stated in the following Table II.:—

TABLE II.

	W	$a:b:c$	x	y	z
$C_{10}H_{14}O_3$...	60	1·0011 : 1 : 1·7270	3·2654	3·2618	5·6331
$C_{10}H_{18}O_4$, $1/2\,(CH_3)_2CO$	74	1·2386 : 1 : 1·7172	4·0435	3·2646	5·6060

The ratio c/b is approximately the same in the two cases and general similarity exists between the two crystalline substances. It will be observed that the values of a/b are very nearly in the ratio of the sums of the valencies, W, making up the two molecular complexes, namely, $60:74=100:123$. This and similar cases may be more conveniently discussed with the aid of the so-called equivalence parameters; these are the edge lengths, x, y, and z, of a parallelepipedon of which the volume is W, the sum of the valencies in the molecule, and of which the linear and angular dimensions express the crystallographic axial ratios. Thus, for orthorhombic substance $xyz=W$, and $x:y:z=a:b:c$; the equivalence parameters of the two substances under discussion are given in the table, and it will be seen that whilst y and z are almost identical for the two, the z values differ considerably. This correspondence indicates clearly that in passing from camphoric anhydride to the acetone compound of the acid the mass added to the molecular complex, $H_2O+1/2(CH_3)_2CO$, occupies a volume proportional to the number of valency units which its contributes to the structure.

A very remarkable relation has been long recognised between the crystalline forms of the three minerals chondrodite, $Mg_3(SiO_4)_2$, $2Mg(F,OH)$, humite, $Mg_5(SiO_4)_3$, $2Mg(F,OH)$, and clinohumite, $Mg_7(SiO_4)_4$, $2Mg(F,OH)$; the crystalline forms are referable to three rectangular directions, a, b, and c, and the ratio $a:b$ is practically the same for all three minerals. The relationship is at once elucidated by the law of valency volumes in a simple manner. In the molecules of the three substances the sums of the valencies of the constituent atoms are respectively 34, 48, and 62; it follows from the law that these numbers are proportional to the relative volumes of the several molecules. The ratios, $a:b:c$, being known, the dimensions can be calculated of solid rectangular blocks having these volumes and having edge lengths proportional to the axial ratios, $a:b:c$. The equivalence parameters, x, y, and z, thus calculated are given in the following Table III.; the first observation of importance to be made is that the equivalence parameters, x and y, remain practically constant throughout the series of three minerals.

It will be seen that chondrodite and humite, and humite and clinohumite, differ in molecular composition by the quantity, $Mg_2(SiO_4)$; they form a series in which the increment of composition is $Mg_2(SiO_4)$. Subtracting this increment from the composition of chondrodite, the residue, $Mg_2(SiO_4)$, $2Mg(F,OH)$, is left. This is the composition of the mineral prolectite, and the increment, $Mg_2(SiO_4)$, is the composition of the mineral forsterite.

If the law of valency volumes be correct the equivalence parameters of forsterite should be the x and y of the first three minerals, and a value z which is the difference between the z values of chondrodite and humite, or of humite and clinohumite; further, prolectite should have x and y values identical with those of the other four minerals and a z value which is the difference of the z values of chondrodite and forsterite. It is thus possible to calculate the equivalence parameters of forsterite and prolectite without using data determined on these two minerals, and to compare the values so obtained with those calculated from

the observed axial ratios of forsterite and prolectite. All the values referred to are given in Table III., and it will be obvious that the agreement between the calculated and the observed equivalence parameters is very close; as this agreement could not occur without the operation of the law of valency volumes, which was deduced from entirely different data, strong confirmation of the accuracy of the law is provided.

TABLE III.

Minerals	W	Axial Ratios			Equivalent Parameters			z/W
		a	: b :	c	x	y	z	
Chondrodite ...	34	1·08630	: 1 :	3·14472	2·3367	2·1510	6·7644	0·19895
Humite ...	48	1·08021	: 1 :	4·40334	2·3343	2·1610	9·5155	0·19824
Clinohumite ...	62	1·08028	: 1 :	5·05883	2·3384	2·1646	12·2491	0·19756
Prolecite: observed	20	1·0803	: 1 :	1·8862	2·3130	2·1414	4·0385	0·19977
Prolectite: calculated	20	1·0818	: 1 :	1·8618	2·3365	2·1589	4·0211	0·19968
Forsterite: observed	14	0·9296	: 1 :	1·1714	2·3426	2·1778	2·7442	0·19601
Forsterite: calculated	14	0·9240	: 1 :	1·1741	2·3365	2·1589	2·7433	0·19585

The several illustrations of the operation of the law of valency volumes have been quoted in detail for the purpose of showing how difficult it is to avoid the conclusion that this deduction represents some physical reality. It may be traced in connection with quantitative data of other kinds; during the last few years it has been very successfully applied by Le Bas to the interpretation of the molecular volumes of liquid substances.

From what has been already said it will be seen that the great problem as to the relation between crystal structure and chemical constitution, of which the solution seems imminent, is a stereochemical one; assemblages must be built up in accordance with the principle of homogeneity and in some form of close-packing, in which each component atom of a chemical molecule is represented as the sole occupant of some specific solid area. The properties of these assemblages must also be in agreement with the crystallographic measurements and the X-ray photographs yielded by the substances represented.

A brief indication may be given of what has been already effected in this connection. The normal paraffin hydrocarbons of the general composition C_nH_{2n+2} consist of a chain of the composition $(CH_2)_n$, to each end of which one hydrogen atom is attached; in accordance with the principles already indicated, a close-packed assemblage of the empirical composition CH_2 can be constructed from carbon and hydrogen spheres of the respective volumes 4 and 1, of such a nature that it can be divided by planes into blocks, each made up of strings of the composition $(CH_2)_n$, or $.CH_2\ .CH_2\ .\ .\ .\ .\ CH_2\ .\ CH_2$. At each plane of cleavage of the assemblage hydrogen spheres can be inserted in appropriate numbers so that close-packing is restored when the cleavage faces are brought together again; the assemblage will then have the composition $H\ .\ (CH_2)_n\ .\ H$, and may be geometrically partitioned into units each representing one molecular complex of a normal paraffin. It is noteworthy that these units exhibit the configurations indicated by the van 't Hoff-Le Bel conception for the normal paraffins. Other assemblages can be constructed which represent in a similar manner the secondary and tertiary paraffins, and all these assemblages are of one particular geometrical type, that which corresponds to the chemical behaviour characteristic of the paraffins. In these assemblages replacements may be effected so as to introduce new geometrical features of arrangement corresponding to the presence in the molecule of an ethylenic or an acetylenic bond, and thus other classes of hydrocarbons can be represented in accordance with the conception of close-packing; the process can be extended to the polymethylene and aromatic hydrocarbons and to their substitution derivatives, and throughout a close correspondence is observed between the numbers of isomerides possible, with their constitutions and configurations, and the experimental facts.

Many considerations indicate the fruitfulness of the mode of regarding organic substances just briefly sketched; one may be more particularly specified. An assemblage representative of benzene has been suggested which accords with the crystalline form and chemical properties of the hydrocarbon, and can be geometrically partitioned into units, each representing a single molecule. The equivalence parameters of the substance are

$$x : y : z = 3{\cdot}101 : 3{\cdot}480 : 2{\cdot}780.$$

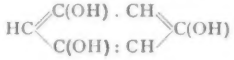
The dimension y is twice the diameter of a carbon sphere, and that of z slightly less than the sum of the diameters of a carbon and a hydrogen sphere. Now a dimension approximating closely to the z value for benzene can be found amongst the equivalence parameters of large numbers of aromatic compounds, indicating that in these crystalline substances the benzene complexes are stacked one upon the other so as to preserve the z dimension, but that the columns so formed are pushed apart in the derivatives to an extent sufficient to admit of the entrance, in close-packing, of the substituting radicles. A few cases of this kind were quoted by Barlow and myself, and many others were discovered by Jerusalem;[6] quite recently the subject has been subjected to a very thorough quantitative examination by Armstrong, Colgate, and Rodd.[7] The exhaustive nature of the experimental work of these latter authors and the care with which their conclusions are drawn leave little room for doubt as to the accuracy of their main contention, namely, that the crystallographic method affords material from which the stereochemical configurations of aromatic substances can be deduced.

If cystallography is to be used as a tool in the service of stereochemistry in anything like the way which has been briefly sketched in this address, a number of important results should accrue. We have seen that in the structure assigned to rock-salt, each sodium atom is identically related to six chlorine atoms; only when the crystal is disintegrated by solution in water does the necessity arise for a choice to be made, the sodium atom then selecting one particular chlorine atom as a mate. Even then the sodium chloride molecule present in solution appears to spend the greater part of its time in dissociation, namely, in the act of changing its partner. There is thus in the theory of crystal structure something which bears a superficial relationship to electrolytic dissociation, and the further study of this aspect of the subject may be fruitful.

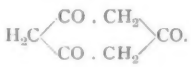
Again, the solid crystalline structures which we have attempted to build up present, as one essential feature, the property that they can be partitioned geometrically into unit cells, each composed of one molecule of the substance; thus, the rock-salt structure can be partitioned into cells each representing the molecule NaCl. In this instance, the partitioning can be performed

6 Trans. Chem. Soc., 1909, 95, 1275.
7 Trans. Chem. Soc., 1910, 97, 1578; Proc. Roy. Soc., A, 1912, 87, 204; 1913, 89, 232; 1914, 90, 111.

in a variety of ways corresponding to the allocation of one particular sodium atom to either of six chlorine atoms; the alternative modes of partitioning lead to the production of molecular units of identical configuration. In many cases, however, alternative methods of geometrically partitioning the assemblage representing the crystalline structure do not yield units of the same configuration; thus, the assemblage representing phloroglucinol can be geometrically partitioned in two distinct ways. Each of these gives a unit of the composition $C_6H_6O_3$, but the configuration of the unit of the one partitioning corresponds to the chemical structure of the 1 : 3 : 5-trihydroxybenzene,



whilst the other exhibits the structure of the symmetrical triketohexamethylene,



A new suggestion is thus made to the effect that tautomerism consists in the possibility of geometrically partitioning the close-packed assemblage in two or more alternative ways, each giving molecular units of the same composition but of different constitutions. The idea that in the occurrence of tautomerism some component atom wanders from one position to another in the molecule is thus rejected; the change in constitution arises from the transference of atoms as between two or more molecules. As the older conceptions of the mechanism of tautomerism do not provide a satisfactory explanation of the experimental facts, the suggestion now made is perhaps worthy of consideration.

The new line of work has many bearings upon the subject of chemical change; thus, the assemblage which is assigned to acetylene (or methylacetylene) is convertible, by symmetrical distortion, into that representing benzene (or the 1 : 3 : 5-trimethylbenzene, mesitylene. Further, the great change in chemical behaviour which accompanies many types of chemical substitution is possibly connected with the manner in which the actual atomic volumes are affected by the replacement; on converting benzene, in which the atomic volumes of carbon and hydrogen are as 4 : 1, into bromobenzene, a considerable increase in molecular volume occurs. The atomic volumes of carbon and hydrogen still, presumably, preserve the 4 : 1 ratio, and the volume appropriated by the entering bromine atom is approximately the same as that occupied by each hydrogen atom already present; the actual atomic volumes of carbon and hydrogen must thus be supposed to have increased during the production of bromobenzene. It can hardly be supposed that this fundamental volume change, even apart from a distortion of the aromatic ring arising from slight inequality of hydrogen and bromine atomic domains in the molecule, could occur without the exhibition of considerable differences in chemical properties as between benzene and bromobenzene.

Whatever view may be taken as to the accuracy of the conclusions concerning the relation between crystal structure and chemical constitution which are briefly discussed in the present address, no critic will be disposed to doubt that wide developments in chemical science will result from the cultivation of crystal study: it seems clear that any satisfactory theory of the solid state must be largely crystallographic in character. The chief hindrance to progress at present consists in the lack of chemists trained in modern crystallographic methods; in my own country the only school in which chemical students were trained in crystallography, dissociated from mineralogy, was founded by Dr. Henry E. Armstrong and Sir Henry A. Miers in 1886. After doing a vast amount of valuable educational work this school has recently been allowed to become extinct.

In a presidential address to the Mineralogical Society in 1888, Mr. Lazarus Fletcher remarked that "a knowledge of the elements of crystallography, including the mechanics of crystal measurements, ought to be made a *sine qua non* for a degree in chemistry at every university." Twenty-five years later we find that no European university has applied this principle, and in consequence the chemical crystallographer has the greatest difficulty in making himself intelligible to his purely chemical colleagues. May I, in concluding, express the hope that the colonial universities, less fettered by tradition than their older sisters, may lead in the work of placing the subject of crystal structure in its legitimate position as one of the most important branches of modern physical chemistry?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—The Principal wishes it to be known that the University will do what it can to safeguard the academic interests of undergraduates on military duty. In relation to attendance on courses of instruction, to duration of study, to periods of notice required, etc., account will be taken of a student's absence on military duty to ensure, if possible, that his graduation shall not be unduly delayed.

THE authorities of the Royal Agricultural College, Cirencester, wish it to be known that every endeavour will be made to prevent students who are undertaking army or other patriotic work from being thereby penalised as regards their courses of study.

THE Vice-Chancellor of the University of Liverpool states that although the Council and Senate have not met since the declaration of war, it may be assumed (1) that the University courses will begin on the appointed day; (2) that in due time everything will be done that can be done to safeguard the interests of members of the staff and of students who have offered themselves for national service at home or abroad. It is also announced that at Durham University the term will begin as usual in October, and that no member of the Durham Colleges will suffer any academic disability by reason of absence on any form of national service.

THE fifty-fifth annual report of the Cooper Union for the Advancement of Science and Art has been received from New York. The union governs and finances many departments of higher education, and in the report its director gives full particulars of the work done during the year ending June, 1914, and directs special attention to the development of the technical school. We notice the resignation of Prof. Robert Spice, after twenty-five years' service in Cooper Union as professor of chemistry and head of the department of chemistry. Since 1900 Prof. Spice has devoted the whole of his time to the Cooper Union; beginning with some twenty students the attendance has steadily increased until now the limits of the capacity of his department have been reached.

THE Vice-Chancellor of the University of Wales has written to the Press to say that he is prepared to undertake that the University will arrange that, in the case of students who entered the University in 1911, the coming session shall not be reckoned as the last of the four years beyond which honours in the B.A. or B.Sc. degree cannot be obtained, so that they may complete honours schemes in the session 1915–16 under the same conditions under which they would have completed them in the coming session. He says it will be understood that, as pursuance of qualifying courses is essential for initial degrees, a year of absence cannot be reckoned as a year of the qualifying period; but, subject to this proviso, he has no doubt that the University will be anxious to consider cases of disability arising, other than the one above provided for, with the view of making special arrangements for their relief.

THE former circular on geometry, issued five years ago by the Board of Education, has exercised a marked and unquestionably beneficial influence on elementary education. We do not know of any geometrical text-book, published since that date, which has not taken account of it, and we have frequently directed attention to it in these columns. That circular is now out of print, and the Board has, therefore, drawn up the present memorandum (*Memorandum on the Teaching of Geometry in Secondary Schools*) which covers the same ground, slightly more elaborately. Now that it is generally recognised that Euclid's postulates are far from being exhaustive, and that any philosophically complete set involves abstract considerations, wholly unsuitable for immature minds, there seems to be a growing consensus of opinion in favour of widening the basis of deduction, and including in it such spatial ideas as the ordinary boy (when he appreciates the significance of the statements made) regards as obvious. A proof which is not the cause of intellectual conviction, if only because belief exists independently, stands *ipso facto* condemned. The basis which has been suggested includes the fundamental properties of angles at a point, parallelism, and congruence. This provides a perfectly intelligible system of postulates and requires nothing which will present any difficulty to a boy who is capable of geometrical work of any kind, if the facts are presented to him in a satisfactory manner; and it enables him to proceed to apply deductive methods to the establishing of properties of which he realises the need of proof, thus arousing in him that interest which springs from a recognition of the utility of his work.

BOOKS RECEIVED.

The Vaccination Question in the Light of Modern Experience. By Dr. C. K. Millard. Pp. xvi+244+10 plates. (London: H. K. Lewis.) 6*s*. net.

Suggestions for a Course in Climatology in Correlation with Geography. By W. E. Whitehouse. Pp. 31. (Aberystwyth: University College.) 1*s*.

Report on Scottish Ornithology in 1913, including Migration. By E. V. Baxter and L. J. Rintoul. Pp. 96. (Edinburgh: Oliver and Boyd.) 1*s*. 6*d*. net.

General Report on the Operations of the Survey of India during the Survey Year 1912–13. Pp. x+43+maps. (Calcutta: Survey of India.) 3*s*.

Memoirs of the Geological Survey of India. Vol. xli. Part 2: On the Geology and Coal Resources of Korea State, Central Provinces. By Dr. L. L. Fermor. Pp. iv+148–245. Vol. xlii. Part 1: The Burma Earthquakes of May, 1912. By J. C. Brawn. Pp. vi+147. (Calcutta: Geological Survey of India; London: Kegan Paul and Co., Ltd.) 4*s*. each.

Annals of the South African Museum. Vol. x.: Descriptions of New Species of Lepidoptera Heterocera in the South African Museum. By W. Warren. Pp. 467–510+2 plates. (London: West, Newman and Co.) 6*s*.

Ninth Annual Report of the Meteorological Committee, for the year ended March 31, 1914. Pp. 69. (London: Wyman and Sons, Ltd.) 4*d*.

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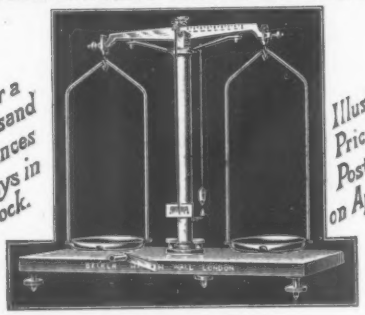

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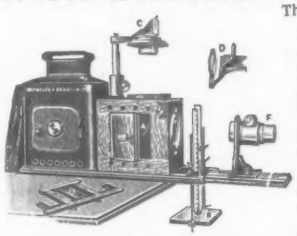

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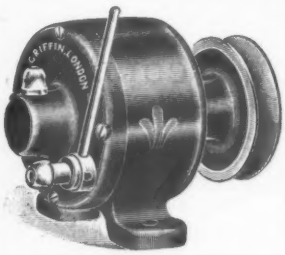

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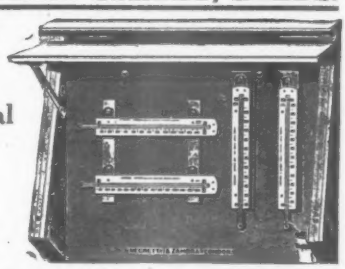

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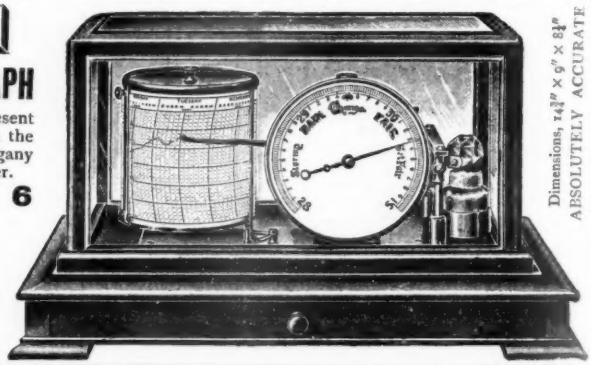

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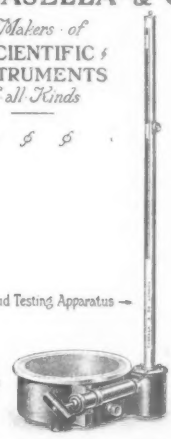

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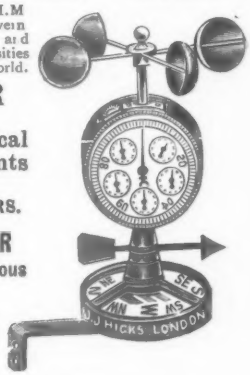

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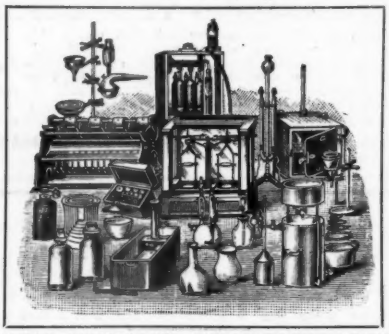

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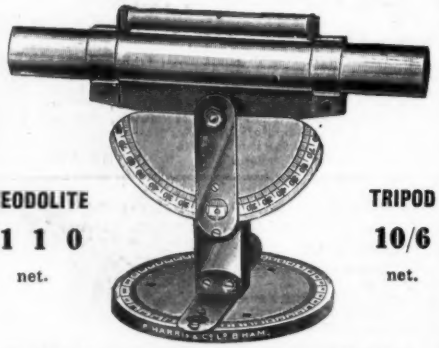

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